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MINERAL FUELS TAXATION IN THE OLD WEST REGION

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MINERAL FUELS TAXATION
IN THE
OLD WEST REGION

Prepared for
The University of Montana
under a grant from
THE OLD WEST REGIONAL COMMISSION

Prepared by
Mountain West Research, Inc.
Billings, Montana

1 October 1979

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EXECUTIVE SUMMARY

Overview

Mineral fuels extraction has long been an important economic activity in the five-member states of the Old West Regional Commission (Montana, Nebraska, North Dakota, South Dakota and Wyoming). It has assumed even greater significance during the last decade as development of the region's oil, natural gas, coal, and uranium resources has been hastened by demands of the national energy "crisis". During that same decade, most of the Old West states adopted important changes in their fiscal policies toward mineral fuels. Some of these policies have since been challenged, both inside and outside the region. Mineral fuels taxation in the Old West Region has thus become a current issue of some importance. Recognizing that fact, the Old West Regional Commision provided a grant to the University of Montana to analyze mineral fuels taxation in the region. This report presents the findings of that research.

The specific objectives of the research can be summarized as follows:

1) To up date and summarize present mineral fuels taxes in the Old West states;
2) To describe the theoretical basis of mineral fuels taxation in the United States;
3) To briefly analyze and describe the mineral fuels industries in the Old West Region;
4) To qualitatively determine the probable direction and magnitude of the interstate shifting of taxes on coal;

5) To determine the importance of interstate shifting of mineral fuels taxes in the Old West states compared to the interstate shifting of other taxes by other states; and,

6) To investigate and qualitatively assess the total costs (economic and social) imposed on the Old West states by mineral fuels development.

In meeting these objectives, the main report has been organized into seven chapters:

Chapter 1 Introduction. Provides an overview of the policy context of the research project.

Chapter 2 Definitions and Concepts of Mineral Fuels Taxation. Outlines the basic principles involved and the types of taxes levied.

Chapter 3 Rationale for Mineral Fuels Taxation. Explains the underlying purposes of mineral fuels taxes.

Chapter 4 Historical Development of Mineral Fuels Taxation in the Old West Region. An updated review of the evolution and status of present tax mechanisms.

Chapter 5 Mineral Fuels Industries in the Old West Region. Historical development and future outlook of mineral fuels production in the Old West states, with an emphasis on coal.

Chapter 6 Impacts, Incidences and Interstate Shifting of Different Mineral Fuels Taxes. Analyzes the factors determining the degree to which taxes on coal are exported to out-of-state parties and compares that phenomenon with the exporting of taxes by all states.

5) To determine the importance of interstate shifting of mineral fuels taxes in the Old West states compared to the interstate shifting of other taxes by other states; and,

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Chapter 6 Impacts, Incidences and Interstate Shifting of Different Mineral Fuels Taxes. Analyzes the factors determining the degree to which taxes on coal are exported to out-of-state parties and compares that phenomenon with the exporting of taxes by all states.

Chapter 7 The Costs Imposed by Mineral Fuel Development in the Old West States: The Case of Coal. Addresses the magnitudes and quantification problems associated with social overhead costs and external diseconomies due to coal development.

In addition, the document includes a bibliography and two appendicies.

Key Findings

The most important research findings are contained in Chapters 6 and 7. In Chapter 6, application of basic economic principles and incidence theory leads to the conclusion that taxes on coal covered by long term supply contracts are likely to be almost entirely borne by the ultimate electrical utility customer. Since most such customers are located outside the region, these coal taxes are largely exported. However, for coal not under long-term supply contracts at the time a tax is imposed or changed, the tax burden will principally fall on the effective owner -- either legal owner or leaseholder -- of the resource. Given that coal produced in the region is nearly 100 percent sold under long term contract, in the short-run, taxes on Old West states' coal must be largely exported.

To place the region's coal tax exports in a national context, the degree to which taxes of all types are exported by all states was estimated, based upon an update of the seminal 1966-67 work of Charles McLure. State income taxes, taxes on production, consumption, and corporations, property taxes and severance taxes were examined. The results of the 1977 update are very revealing. Of eleven states examined for all taxes, only Montana, Nevada, and Wyoming did not increase the percentage of their state tax collections exported to

residents of other states in the long run. As Tables 1 and 2 illustrate, both Michigan and Nevada export a larger share of their 1977 taxes in the short run than any Old West state, while Nevada also exports a greater share in the long run. South Dakota ranks eleventh in both the short and long run. Overall, there has been a slight increase in the degree of interstate tax shifting among all states.

Certain of the legal challenges to Old West states' mineral fuels taxation policies have argued that the taxes should be levied in a manner to produce revenues commensurate with the benefits provided by the taxing states -- by implication, commensurate with the costs imposed on the states by coal development. This argument presupposes that the benefits and costs of coal development are measurable and quantifiable. Chapter 7 examines that supposition in some detail by reviewing the state-of-the-art in economic analysis with regard to the quantification of a host of social overhead costs and external diseconomies.

The evidence is overwhelming that large uncertainties are inherent in even the most refined estimates of social overhead costs, particularly as they are reflected in forecasts of net fiscal impacts on state and local governments. Moreover, present economic analysis techniques are unable to quantify the costs of a large number of important externalities in any meaningful way. For example, it is widely conceded that in areas of intensive research, such as the health effects of air pollution, total economic costs continue to be significantly underestimated. While the value of the external diseconomies generated by coal development is intuitively important -- perhaps dominant -- in comparison to that of the net fiscal effects (resulting from increases in social overhead costs), no

methods exist by which that value can be meaningfully quantified.

In sum, the social overhead costs of coal development cannot be determined with any certainty, while the potentially more important external costs cannot be meaningfully estimated at all. Thus, benefits criteria cannot practically be used to establish appropriate levels for coal taxes.

TABLE 1

The Interstate Incidence of State Tax Collections
Short Run

State	1962 Value of Exported Taxes (Million $)	1962 Percent of State Taxes Exported	1977 Value of Exported Taxes (Million $)	1977 Percent of State Taxes Exported
California	1,208.6	23.5	5,791.6	24.3
Florida	214.4	20.2	1,074.5	20.2
Illinois	622.9	25.3	2,541.3	26.2
Michigan	557.5	29.4	2,448.4	31.2
Montana	39.7	24.5	147.7	25.4
Nebraska	50.3	18.6	261.7	21.6
Nevada	34.6	36.3	196.7	34.8
North Dakota	27.0	20.0	92.9	21.1
South Dakota	25.9	17.0	72.6	17.0
Wisconsin	240.7	24.7	974.4	24.2
Wyoming	21.1	25.8	101.6	25.1
Weighted Average		24.8		25.6

TABLE 2

The Interstate Incidence of State Tax Collections
Long Run

State	1962 Value of Exported Taxes (Million $)	1962 Percent of State Taxes Exported	1977 Value of Exported Taxes (Million $)	1977 Percent of State Taxes Exported
California	1,002.9	19.5	4,781.6	20.0
Florida	199.5	18.8	1,088.6	20.4
Illinois	509.6	20.7	2,082.2	21.5
Michigan	403.9	21.3	1,716.8	21.9
Montana	35.5	21.9	124.2	21.3
Nebraska	46.8	17.3	290.0	23.9
Nevada	33.2	34.9	187.1	33.1
North Dakota	25.0	18.5	85.4	19.4
South Dakota	24.8	16.3	70.8	16.6
Wisconsin	170.6	17.5	741.1	18.4
Wyoming	19.1	23.3	91.5	22.6
TOTAL	2,470.9	20.0	11,259.3	20.8

FOREWORD

This report documents the results of a study of mineral fuels taxation in the Old West states of Montana, Nebraska, North Dakota, South Dakota, and Wyoming.

Impetus for the research was provided by changing fiscal policies with respect to energy resources in the Old West states as well as by challenges from outside the region to those changing policies. The objectives of the study were:

1) To update and summarize present mineral fuels taxes in the Old West states;
2) To describe the theoretical basis of mineral fuels taxation in the United States;
3) To briefly analyze and describe the mineral fuels industries in the Old West Region;
4) To qualitatively determine the probable direction and magnitude of the interstate shifting of taxes on coal;
5) To determine the importance of interstate shifting of mineral fuels taxes in the Old West states compared to the interstate shifting of other taxes by other states; and,
6) To investigate and qualitatively assess the total costs (economic and social) imposed on the Old West states by mineral fuels development.

The project was supported by Grant No. 10871232 from the Old West Regional Commission to the University of Montana which was responsible for the overall direction of the project. Mountain West Research, Inc. of Billings, Montana, performed the research and prepared this report as subcontractor to the University of Montana. Participating for Mountain West Research were:

James Moore - Project Manager
Jack Tomasik - Economist
Ryan Amacher - Consultant in Public Finance
Regan Whitworth - Consultant in Resource Economics

Mountain West Research is commended for its efficient and careful conduct of the research effort. Thomas F. Kiely, Project Coordinator in the Billings office of the Old West Regional Commission, was especially helpful and cooperative in many ways. The University of Montana is grateful to the Old West Regional Commission for the opportunity to again serve the region by directing attention to and providing valuable information about a topic of immense importance.

The contents of this Final Report in no way represent the opinions or policies of either the University of Montana or the Old West Regional Commission. Responsibility for them rests with the authors alone.

Rudyard B. Goode
Professor of Finance
Project Director

1. INTRODUCTION

1. INTRODUCTION

Mineral fuels extraction has long been an important economic activity in the five-member states of the Old West Regional Commission (Montana, Nebraska, North Dakota, South Dakota, and Wyoming). Over the past ten years, mineral fuels production in several of these states has increased significantly, while heightened exploration activity has been experienced in all of them. Moreover, during the same period, the taxes levied on mineral fuels have grown in importance in Montana, North Dakota, and Wyoming.[1] Recently, the taxation policies of some of the Old West states have been criticized as being excessive (Lopach, 1978), and the severance tax levied on coal in Montana is currently being challenged in the courts by a group of utilities and mining companies. Both because of the growing importance of mineral fuels to the region's economy and because of the increasing intensity of the debate regarding appropriateness of taxation policies currently applied to this industry, the Old West Regional Commission funded a study in 1978 to analyze mineral fuels taxation in the Old West Region.

1.1 Policy Context of Mineral Fuels Taxation in the Old West States

Since 1970, a succession of national and international economic and political events has drawn increasing attention to the long-developing problem of oil and natural gas resource depletion in the United States. The Arab Oil Embargo and the formation of the OPEC cartel in 1973 precipitated the adoption of energy self-sufficiency as a top national priority. Indeed, the theme of energy independence has been echoed by the last three administrations in Washington. Moreover, the rapidly rising costs and increasing shortages of energy -- particularly, oil and natural gas -- have directly affected the national economy and, in one way or another, every citizen.

[1] While mineral fuels tax rates were increased in South Dakota, they still contribute a relatively insignificant amount of revenue to the state treasury.

As a result of declining domestic reserves of other fossil fuels, the Arab Oil Embargo, and the abundance of accessible deposits, coal has assumed a paramount position in national energy plans. Moreover, the heightened interest in coal came at a time of increasing concern with environmental quality. The consequent development of national and state standards for sulfur dioxide emissions significantly enhanced the attractiveness of western states' reserves of low sulfur coal. Because of its vast reserves of low sulfur, strippable coal, and other energy resources, both public and private energy policy decision-makers have cast the Old West Region in a leading role on the path toward national energy independence. By the mid-seventies, coal, uranium, and oil shale reserves in the region and surrounding states had been targeted for rapid development, and their development began to take place -- although more slowly than envisioned in initial projections.[1]

The relatively rapid development since 1970 of mineral fuels resources in the Old West Region has inevitably run into conflicts with traditional land uses, values, and lifestyles. A growing chorus of concern regarding impacts of energy resource development on the natural and human environments began to be heard from both inside and outside of the region.[2] Within the region, one aspect of this concern related to the costs that energy resource development imposed on individuals, state and local governments, and future generations. This

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[1]The slower rate of new energy resource development has been due to several factors, including (1) the absence of a coherent national energy policy, (2) environmental preservation activism and regulation, (3) overly optimistic assumptions regarding the energy industry's ability to expand production in the existing regulatory environment and given the lead times required for capital equipment orders, and (4) private sector uncertainties regarding the long-term profitability of major capital commitments in view of the instability of government policy and energy prices as well as the rapid inflation of construction and operating costs.

[2]It should be noted that the "chorus of concern" within the region has by no means been harmonious. Overall, however, there seems to be general agreement among the Old West States on the need to exercise more influence over the conditions under which energy resources are developed within their boundaries. The theme "development on our terms" has been echoed throughout the region.

helped to stimulate a review and revision of states' mineral fuel taxation policies by all of the legislatures in the Old West Region, except Nebraska's. In general, tax rates were adjusted upward; and in 1978, in response to the Montana legislature's 1975 enactment of a 30 percent severance tax on surface mined coal, legal challenges were initiated by consumer utilities and several mining companies.

1.1.1. Mineral Fuels Development

Since 1970, overall mineral fuels development within the Old West Region has increased dramatically. This development has been led by coal (Montana, North Dakota, and Wyoming) and uranium (Wyoming). Coal production increased from 16.3 million tons in 1970 to approximately 99.5 million tons in 1978. Wyoming production accounted for over 60 percent of the increase. Regarding uranium, Wyoming production expanded 67 percent from 1972 to 1977, reaching approximately 4.0 million tons of ore. On the other hand, total oil and natural gas production declined during the same period, although Montana registered over a 10 percent gain in natural gas and North Dakota and South Dakota increased their crude oil outputs. At the same time, due to rapidly rising prices, oil and gas exploration activity increased by 26 percent between 1976 and 1978.[1] As a result of this heightened activity, regional production will at least stabilize and possibly increase over the near term. The longer term outlook is less clear. Chapter 5 deals with the historical and probable future evolution of mineral fuels production in greater detail.

1.1.2 Regional Issues and Concerns Regarding Mineral Fuels Development

Both the general growth implications as well as the technology-specific impacts of present and projected energy resource developments have engendered the articulation of a wide variety of issues and concerns within the Old West Region. Among these, the following can be cited as of particular importance: (1) water requirements and water quality effects, (2) despoilation of scenic lands, (3) reduction of prime farmland acreage, (4) demographic change, (5) adverse impacts on the quality

[1] In terms of number of wells drilled

of life (particularly in rural communities),(6) fiscal imbalance, (7) boom/bust cycles and economic diversification, (8) air pollution, (9) reclamation, (10) adverse impact on wildlife and vegetation, (11) increased social problems, including child and drug abuse, alcoholism, increased crime and anomie, (12) changes in traditional power structures, and (13) inflationary pressures on local costs of living.

In terms of perceptible socioeconomic impacts, coal and (more recently) oil and gas developments have been the most important. In response, the state legislatures of Montana, North Dakota, and Wyoming have set up impact mitigation funds and mechanisms.[1] They have also increased their mineral fuels tax levies, as a hedge against the present and future costs of development, to slow the rate of development, and to take advantage of the additional revenue opportunities afforded by mineral severance. Further, state legislatures have enacted a broad range of environmental protection laws designed to regulate the pace, location, and character of resource development.

1.1.3 Policy Challenges to Mineral Fuels Taxation

As Old West states increased their taxation of mineral fuels, the appropriateness of these fiscal policies began to be questioned. Of the arguments brought to bear, the most important were:

1) Conflict with national policy. Increased taxes on mineral fuels -- on coal, in particular -- create economic disincentives for their use at a time when national energy policies and Clean Air Act Amendments (1977) require increasing reliance on them.

2) Excessive taxation. The mineral fuels tax burdens imposed by some Old West states are argued to greatly exceed the benefits provided by those states for mineral fuel development as well as the costs imposed on them by that development.[2]

3) Discrimination against interstate commerce. Since the greater part of the mineral fuels production in the region is exported to consumers outside the region, it is argued that high mineral fuels taxes discriminate, in economic terms, against sales to other states. In particular, the taxes are seen as

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[1] In its last (1979) legislative session, South Dakota also established an energy impact fund.

[2] As we shall see in Chapter 7 of this report, available economic techniques render any meaningful determination of such costs and benefits impossible.

imposing an excessive burden on interstate commerce and as having been set at excessively high rates largely because they would be paid by out-of-state consumers.[1] The Montana coal severance tax has come under particular attack on these grounds.

In sum, the higher mineral fuels taxes of some states have been characterized as opportunistic and unfair as well as inimical to national energy policies. For example, the Rand Corporation, in a study of coal development and government regulation in the Northern Great Plains (Rand, 1976), termed the tax policies of Montana and several other western states as OPEC-like revenue maximization. As Montana's Governor Judge said: "Some people are calling us the blue-eyed Arabs " (Washington Post, 1977).

1.2 Legal Challenges to Mineral Fuels Taxation

The present research on mineral fuels taxation is all the more timely in view of recent legal challenges to certain states' energy resource tax policies. Of most direct interest are the suits brought by eleven electric power utilities, four mining companies, and the Crow Indian Tribe against the state of Montana regarding its coal severance tax. Two other recent examples include the suit brought by the state of Arizona against New Mexico concerning the excise tax on exported electricity and Post Oak Oil Company vs. State of Oklahoma.

1.2.1. The Montana Coal Severance Tax Legal Challenges

In their suits against the state of Montana, the plaintiffs (eleven utilities and four mining companies) admit the right of the state to impose a severance tax on coal but argue that the 30 percent rate is an "amount grossly exceeding any 'fair share'." (Commonwealth Edison, et al. vs. State of Montana, et al., 1978). The plaintiffs' brief attacks the constitutionality of the Montana coal severance tax on

[1] Economists term this effect "interstate tax shifting" or tax exporting. Chapter 6 is devoted to this question.

several counts:

1) The tax rate represents an unfair burden on interstate commerce.
2) The economic effects of the tax are contrary to and frustrate national energy and clean air policies.
3) In the collection of this tax, Montana has, in effect, appropriated the economic rents from the development of federally-owned coal resources that belong to the nation as a whole.

In July 1979, the state District Court Judge upheld the defendants' motion to dismiss both suits.

In a corollary action, the Crow Indian Tribe also filed suit in 1978 against the state of Montana's right to levy the severance tax on coal production from Indian lands.

1.2.2 State of Arizona vs. State of New Mexico

The state of Arizona brought suit against the state of New Mexico (Arizona Public Service vs. Stead) regarding the constitutionality of New Mexico's excise on electrical energy generated with the state and exported. The court ruled the tax to be discriminatory against interstate commerce and upheld the plaintiff's case.

1.2.3 Post Oak Oil Company vs. State of Oklahoma

In this case, Post Oak Oil challenged the constitutionality of Oklahoma's conservation excise tax on the production of natural gas. The rate of this tax can range up to one-third the gross value of production. The 1978 decision by the Oklahoma Supreme Court dismissed the plaintiff's complaint (Post Oak Oil Co. vs. State of Oklahoma, 1978).

1.3 Scope of Research and Organization of the Final Report

The foregoing discussion has sketched the context in which the present study of mineral fuels taxation in the Old West Region should be viewed. As will become apparent in later chapters, the theoretical underpinnings of fiscal policy are rather weak in a number of areas. In general, however, the U.S. tax system (federal, state, and local) is premised almost entirely upon ability-to-pay criteria and very little on benefits-received (user tax) criteria. An important conclusion of the

study is, that for mineral fuels taxation, perhaps this is a good thing, since current economic theory is unable to meaningfully estimate the benefits and costs that accompany energy resource development.

This research on mineral fuels taxation has been carried out in two phases. The first phase in the research process was designed to answer several questions about the mineral fuels industry and about mineral fuels taxes. These were: (1) what taxes are levied on mineral fuels in the Old West Region, (2) what has been the historical development of these tax policies, and (3) what avenues of investigation should be followed in Phase II of the study to determine the probable economic incidence of these taxes. Results of the Phase I work with respect to these questions are incorporated in Chapters 2 through 4 of this report and also in Chapter 6 (Section 6.1). These chapters provide, in simplified form, the theoretical background necessary to an understanding of the principles of fiscal policy invoked by each of the mineral fuels tax mechanisms. Phase II of the study addressed: (1) the historical development, outlook, and structure of mineral fuels industries in the region, with an emphasis on coal, (2) the key determinants and likely magnitude and direction of tax shifting for the case of coal, (3) the comparative degree to which tax exportation occurs in the Old West states, and (4) the relationship of mineral fuels taxes to the costs imposed on Old West states by coal development.

This Final Report presents the findings of both the Phase I and Phase II work. It is organized into seven chapters:

Chapter 1 . . . . . Introduction

Chapter 2 . . . . . Definitions and Concepts of Mineral Fuels Taxation. Includes the basic principals involved and the types of taxes levied.

Chapter 3 . . . . . Rationale for Mineral Fuels Taxation. Answers why mineral fuels are taxed.

Chapter 4 . . . . . Historical Development of Mineral Fuels Taxation in the Old West States. An updated description of the evolution of present tax mechanisms.

Chapter 5 . . . . . Mineral Fuels Industries in the Old West Region. Historical development and future outlook for mineral fuels in the Old West states, with a particular emphasis on coal.

Chapter 6 . . . . . Impacts, Incidences, and Interstate Shifting of Different Mineral Fuels Taxes. The case of coal and the national context (all states export taxes and to a greater degree now than fifteen years ago).

Chapter 7 . . . . . The Costs Imposed by Mineral Fuel Development in the Old West States: The Case of Coal. Direct costs, economic externalities, and the uncertain relationship between direct and total costs imposed.

2. DEFINITIONS AND CONCEPTS OF MINERAL FUELS TAXATION

2. DEFINITIONS AND CONCEPTS OF MINERAL FUELS TAXATION

In order to properly understand the implications of mineral fuels taxation for both the energy industry and the taxing jurisdictions, a review of the economic principles of taxation is in order. Following a discussion of several applicable criteria, different types of mineral fuels taxes are evaluated with respect to generally accepted principles of taxation.

2.1 Principles of Taxation Related to Mineral Fuels

When taxation in the United States is discussed in an abstract fashion, two general principles of taxation emerge: the ability-to-pay principle, and the benefits principle. These two principles form the philosophical basis for tax structure design and allow the analyst to better deal with the more elusive concept of equity.

2.1.1 Ability-To-Pay Criteria

The ability-to-pay principle views taxes as independent of the identity of individual beneficiaries of specific public expenditures. A given amount of revenue is needed to support a given level of expenditures, and taxpayers are taxed according to their ability to pay. Ability to pay has usually been correlated with income, but wealth and sometimes consumption have also been used in place of income. The ability-to-pay principle is the basis of the income, property, and sales taxes, each of which is levied based on a different measure of ability to pay without regard to the benefits received by those who pay the tax.

Disagreements over the equity of ability-to-pay taxes are usually disagreements over the best measure of ability to pay. The major choice is between income and consumption, although easily identifiable wealth holdings are often subject to taxation on this principle as well. The proponents of income as the best measure of ability to pay usually win the argument, but it should be kept clearly in mind that economists disagree widely over which is the "best" measure of ability to pay. This is a normative judgment and one that is usually resolved through the political process.

2.1.2 Benefit Criteria

The benefit principle of taxation basically holds that each taxpayer should contribute in proportion to the benefits received from governmental expenditures. This principle thus links taxes and government expenditures (benefits), while the ability-to-pay principle does not. Those benefiting from the activities of government are expected to finance those activities. In fact, a benefits tax can be thought of in many cases as approximating a user charge. For example, mineral fuels are often singled out for special taxation on the basis that mining requires an additional set of governmental expenditures, and that these expenditures should be paid by the owners or users of these fuels.

The benefit principle, while popular in the economics literature, does not have many applications in modern-day governmental finance. In only a few instances, where certain taxes are applied indirectly in lieu of user charges, do these taxes closely approximate the benefit principle. The reason for the small number of benefits taxes is not hard to understand. Most publicly produced goods fall into the "non-excludable"[1] category. These goods, known in the economics literature as public goods, are indivisible in nature and cannot, therefore, be apportioned on the basis of individual payments. Moreover, the non-excludability of these goods is in large part the reason for the good being supplied by public, rather than by private, sources. The non-excludability of any persons who are receiving the benefits makes it very hard to apply benefits taxes, because individuals can avoid the charge and can continue to receive the benefit of the good. Public utilities (e.g., water service) are, on the other hand, typically supported on a use, or benefits, basis, because users who do not pay can be excluded by simply suspending their water service.

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[1] Non-excludable in this use means that the distribution of the good cannot be restricted to the individuals who pay for it. For example, a good police force in a city promotes law and order. This law and order is enjoyed by all the citizens, and it would be impossible to exclude some citizens from the benefits of this service even if they paid no taxes in its support.

The taxation principles applied to mineral fuels are a mixture of both the ability-to-pay and the benefit principle. Many discussions of mineral fuels taxation concentrate on the benefit principle and seek to ensure that the mines pay "their fair share" of the cost of special public expenditures required by the existence of the mine. This is a correct application of the benefit principle; but, emphatically, this does not mean that mine taxation should be limited to the external costs created by the existence of the mine. Application of the ability-to-pay principle implies that the wealth of the mine should support general state and local functions, independent of spending requirements attributable to the mine.

The concepts of equity contained in the ability-to-pay principle and the benefit principle are elusive ones. Equity is often in the eye of the beholder, which results in widely differing ideas about what is "fair." Benefit taxes are more likely to be viewed as being equitable by the taxpaying public than are ability-to-pay taxes. If a specific tax is earmarked for a specific purpose, as is the case in all states for the various highway user taxes, it is often felt by the public that the tax is "fair."

2.1.3 Other Tenets of Taxation

In addition to these principles of taxation, some general tenets exist for a good tax system. However, the implementation of these principles and objectives is not internally consistent; therefore, more nearly approaching one objective results in moving farther away from the achievement of another.

All tax experts agree that the distribution of the tax burden should be "equitable," whether the tax is based on the ability-to-pay principle or on the benefit principle. Once it is agreed that the system should be equitable, however, the definition of "equitability" provides ample fuel for protracted debate.

A second widely accepted tenet is that taxes should be chosen to minimize interference with economic activity. This means that the tax

structure should not cause the behavior of individuals to depart inordinately from what it would have been without the tax. Of course, any tax distorts decision-making to some degree, but the goal is to minimize these distortions. A related aspect of this tenet is the quasi-regulatory role of taxation, which seeks to correct distortions that already exist. The assumption behind this tenet is that a free market economy performs best if market forces are allowed to work themselves out. Governmental policies (e.g., taxes or price controls) that distort or disrupt market forces are believed to diminish overall societal well-being by not allowing the market to function efficiently. Although straightforward in principle, this tenet (like the equitability tenet discussed above) becomes much less clear when applied in practice, because the free market assumption assumes (among other things) that no single buyer or seller of goods and services has the power to influence prices, and that all costs of production are reflected in the prices that are set. If these assumptions of competition do not hold, it is often felt that the public sector must intervene to reestablish an equilibrium that more nearly reflects what the situation would be under free market conditions. For example, if a political decision is reached that private markets are depleting mineral resources at "too rapid" a rate, because individual buyers and sellers are underestimating the long-term value of the resource, an excise tax on these minerals would correct the distortion by increasing the price and thus reducing the quantity demanded of these same minerals. In this way, the minerals would be saved for future generations. Ironically, therefore, one of the results of adhering to this tenet is that taxes are frequently justified on the basis of their ability to offset the distorting influence of other taxes.

A third important tenet of taxation is that the tax should permit efficient administration and that the compliance costs should be low. Since taxes are primarily intended to raise revenue, those that are costly to administer are self-defeating.

In many cases, conflicts among these objectives are inevitable. For example, a tax which corrects for a market imperfection often conflicts with equity concepts by treating taxpayers who are in similar income categories differently. However, the basic principles expressed here can

be used as criteria in evaluating taxes in general and mineral fuels taxes in particular.

2.2 Types of Mineral Fuels Taxes

For this report, the taxation of mineral fuels resources is divided into two general types of taxes. The first type is a tax imposed on the ownership of mineral property; it is based on the value of the property. This tax is referred to as the ad valorem property tax. The second type of tax is based on the production of the mineral resources; it is imposed on some measure of physical quantity or market price of the minerals extracted. In this report, taxes based on the production of mineral fuel resources are referred to as severance taxes. Production-based taxes are categorized in this report as:(1) per-unit taxes, (2) gross-proceeds taxes, and (3) net-proceeds taxes.

It should also be noted that states often use varying nomenclature to refer to production-based taxes on mineral fuels. For example, the state of Montana levies a "license tax" on coal that is based on tonnage (for underground mines) or on gross value (for surface mines). However, because the tax is based on the measure of the resource at the time it is severed, it will be referred to in this report as a severance tax. Furthermore, only those taxes that are imposed in addition to normal taxes levied on businesses within a state are considered here.

2.2.1 Ad Valorem Property Taxes

The ad valorem property tax is the typical means used by most state and local governments to tax real property. It is imposed on the ownership of property and was the first method used to tax mineral resources.

The process of determining tax liability for the ad valorem tax involves the following steps: (1) the determination of the property's "market value" by a state or local assessor ("market value" is normally defined as the exchange price negotiated between a willing buyer and willing seller), (2) the determination of the property's "taxable valuation," which is usually a fixed percentage of market value as defined by law, and (3) the assessment of a charge or "millage rate" against the property's taxable valuation.

The ad valorem tax may be based on the appraisal of market value performed by a state or local assessor, or it may be based on an administrative (Arizona) or a statutory (Colorado, Utah) method of determining the value of the mine (Tippit,et al., 1960).

Like all other taxes, the tax liability under the ad valorem tax involves assessing a tax rate against the tax base. Since the tax base of the ad valorem tax is equal to a fixed percentage of market value, an accurate determination of tax liability requires that the property be appraised as closely to the true market value as possible. In the case of mineral properties, however, a major portion of the value of the property is in the mineral deposit that lies beneath the surface. Moreover, the "value" of the deposit depends upon its worth, less production costs, as it is extracted from the mine over a long period of time. Because the deposit is hidden from view, the exact extent and quality of the resource may not be known; and, therefore, appraisal for ad valorem taxation is difficult. The uncertainty of future costs of extraction and mineral prices also compounds the difficulty of accurate assessment.

Techniques have been developed that would allow the state or local assessor to estimate the value of the resource in place, based on known factors concerning the deposit and on future markets for the resource, but the administration of the ad valorem tax for mineral properties remains difficult. As a result, assessments may be inaccurate and may create inequitable treatment among taxpayers.

Perhaps the most notable economic effect resulting from the levying of an ad valorem tax is that it encourages the firm to attempt to "mine out" from under the tax (Stinson, 1978). That is, the firm is encouraged to increase the rate of extraction, because to do so reduces the amount and the value of the remaining deposit, and thereby reduces the ad valorem tax liability in future years. Therefore, the ad valorem tax induces rapid exploitation of the deposit and discourages conservation of the resource.

Another effect of the ad valorem tax is that it encourages production "high grading"; that is, the strategy of extracting portions of the mineral deposit that either are of greater purity or are physically easier to reach. The ad valorem tax encourages the mine operator to "high grade" in that the tax lowers the profitability of extraction and thereby decreases the body of ore that can be profitably exploited.

One favorable economic effect of the ad valorem tax is that it is an excellent generator of public revenue. Under certain circumstances, it can provide front-end monies for the construction of public infrastructure. Since the tax is not dependent on production, ad valorem tax revenues will be forthcoming during a new mine's construction phase, a time when additional demands on the public sector may be the greatest. In addition, the potential wealth of the mine represents an ability to pay taxes, and it can be argued that it is "fair" that this mineral wealth should support public activities of a general nature.

2.2.2 Severance Taxes

The second major way of taxing mineral fuel resources is through the imposition of taxes on output. The basis of such a production tax may be: (a) physical quantity or (b) a measure of the value of production. Since tax liability does not occur until the mineral is extracted, or "severed," from the earth, we will refer to taxes on mineral production as severance taxes.

Allyn O. Lockner defines the severance tax as:

> ... a levy assessed at a flat or graduated rate on the privilege, process or act of commercially severing or extracting natural resources...as measured by the physical amount or the gross or net value of the natural resources sold or produced (Lockner, 1965).

Institution of severance taxes, or taxes based on the production of natural resources, is largely a development of the twentieth century. Severance taxes were originally implemented as alternative tax mechanisms to the cumbersome ad valorem tax.

As previously mentioned, severance taxes may be levied on the amount of the resource produced or on the value of production. In this paper, a per-unit tax and two forms of value-based severance taxes (gross-proceeds and net-proceeds) will be discussed.

2.2.2.1 Per-Unit Severance Tax

The per-unit severance tax is defined as a constant charge on each physical unit of the resource produced or sold. North Dakota severance tax on coal is an example of a per-unit severance tax.

2.2.2.2 Gross-Proceeds Severance Tax

A gross-proceeds severance tax is defined as a levy on a measure of the total dollar value of the product extracted from the mine. Seventeen states impose the gross-proceeds tax as the principal method of mineral resource taxation. In the Old West Region, the states of Montana and Wyoming tax minerals on a gross value of production basis. North Dakota imposes a gross value tax on oil and gas production.[1]

2.2.2.3 Net-Proceeds Severance Tax

A net-proceeds severance tax is a charge on the net dollar value of the mineral resource, after exemptions and deductions of certain production costs and expenses. The operation of a net-proceeds tax is similar to that of the corporate income tax. The economic effects of a net-proceeds tax, as discussed in Chapters 3 and 6, are identical to those of a corporate income tax. Prior to 1978 legislative action, the

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[1] On the subject of what is considered to be the "true" severance tax, the literature is in apparent conflict. In one report reviewed for this paper, the per-unit severance tax is referred to as the true severance tax (see Stinson, op.cit.). In another report, the gross-proceeds tax is referred to as the true severance tax (see Council of State Governments, Coal: State Coal Severance Taxes and Distribution of Revenue, (Lexington: Council of State Governments, 1976), p. 4.)

South Dakota mineral license tax (on coal, uranium, and petroleum) is based on the net value of production.

In the next chapter, these four types of mineral taxation are identified in each of the Old West states in which they occur. In addition, the tax rate and the legislatively mandated distribution of the funds are noted.

3. RATIONALE FOR MINERAL FUELS TAXATION

3. RATIONALE FOR MINERAL FUELS TAXATION

Taxes have been imposed on the mineral fuels industry for a variety of reasons. In this section, seven rationales for mineral fuels taxation are examined:

1. Revenue Generation
2. Tax Exportation
3. Internalization of Social Costs
4. Taxation of Excessive Profits
5. Control Resource Exploitation
6. Administrative Ease
7. Intergenerational Transfer

In addition, a comparison of the major forms of mineral fuels taxes, as they relate to each rationale, is provided.[1]

3.1 Revenue Generation

Historically, states endowed with abundant mineral fuel resources have relied heavily on them as a base from which to generate public revenues. The state of Texas, for example, derived about nineteen percent of its general fund revenues in 1977 from taxes imposed on mineral fuels, principally oil and gas. Particularly in the 1970s, western coal-producing states have viewed the taxes collected from the mineral fuels industry as a major source of funds for financing such energy-related expenditures as the additional public services and facilities required as a result of coal and uranium development.

The revenue-generating capacity and the equity of mineral fuels taxation are greatly dependent on the specific type of tax imposed. A description of how each of the major types of mineral fuel taxes relates to the generation of public revenue and to equity is presented below.

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[1] Much of the discussion appearing in this section was drawn from Stinson, "State Taxation of Mineral Deposits and Production."

3.1.1 Ad Valorem Property Tax

The ad valorem property tax is imposed on the ownership of property and is based on a measure of the property's worth. In the case of mineral properties, the major portion of value is the mineral deposit located beneath the surface of the land.

In terms of its revenue-generating capacity, the ad valorem tax is an excellent producer of public revenues since tax revenues accrue whether or not the mine is producing. The ad valorem tax is based on wealth, rather than on production, and is levied whether or not the mine is presently generating income. Because the ad valorem tax is independent of production, it can be an excellent way to generate revenue to finance public services and infrastructure during mine construction and development. In areas experiencing rapid mineral development, the greatest demands on public services and facilities are usually felt during the initial construction phases of the project. Since the ad valorem property tax is levied on the value of the mine whether it is producing or not, revenues will be generated prior to actual production. In this way, new demands are better matched with financial resources ; and thus, the front-end financial problems of rapidly developing areas may be mitigated to a certain extent.

3.1.2 Per-Unit Severance Tax

Because the per-unit severance tax is not levied until production actually begins, it cannot alleviate the front-end load problem as well as can the ad valorem tax, as discussed in the last section. Furthermore, unlike the value-based severance taxes discussed below, collections from the flat-rate severance tax do not automatically increase with inflation. However, it is possible to make adjustments in the tax rate to account for inflation; the state of North Dakota, for example, provides a quarterly adjustment of the coal severance tax rate equal to $.01 per ton for each four percentage points increase in the Wholesale Price Index.

3.1.3 Gross-Proceeds Severance Tax

The gross-proceeds severance tax, like the per-unit severance tax,

will not generate revenues during the construction phase of the mine and, therefore, will not resolve the front-end financial problems confronting mineral development areas. However, because the gross-production tax is based on a measure of value, the yield of the tax will automatically rise with increases in the value of production, whether these increases are based on the market forces or on inflationary pressures.

3.1.4 Net-Proceeds Severance Tax

The net-proceeds severance tax also lacks the ability to provide monies to deal with the front-end financing problem during mine construction. Moreover, the net-proceeds severance tax may be more deficient in this regard than either the gross-proceeds tax or the per-unit tax, because the mine might not operate at a profit for several years. Once operation begins, the revenue stream produced by the tax may be subject to considerable variation due to market influences affecting price and production costs. Therefore, it may not be a stable or reliable revenue source.

3.1.5 Equity

The three forms of severance taxes provide greater horizontal and vertical equity in the tax treatment of mining firms than does the *ad valorem* property tax.

Horizontal equity refers to the equal treatment of firms facing similar tax liabilities. It is expected that two mines within the same state, identical in all respects except for location, should be taxed in a uniform manner. However, when the *ad valorem* tax is imposed, it is unlikely that both mines will be appraised at the same level because of the difficulties in appraising mineral deposits, as discussed in Chapter 2. Furthermore, because the *ad valorem* tax is a local levy, subject to the discretion of the local taxing jurisdiction, it is likely that each mine will be taxed at a different rate since each is located within different local taxing jurisdictions. Within a given taxing jurisdiction, severance taxation avoids many of the problems that create horizontal inequities since all mines are assessed a uniform charge in a uniform manner.

Vertical equity refers to the fact that taxpayers who are equal should not be taxed in an unequal manner. Referring to the tenets of taxation, vertical equity is the basis of the ability-to-pay criteria; that is, those firms that are able to pay taxes should do so.

The ad valorem tax is levied independently of the firm's present ability to pay because it is collected whether or not the firm is producing and generating a current income. Severance taxes are more reflective of the firm's ability to pay, since they are based on production. The per-unit severance tax is least suited to the ability-to-pay criteria, since its imposition is not dependent on the value of the mineral. Both the gross-proceeds and net-proceeds taxes take into consideration the mineral's worth, but the gross-proceeds tax does not take into account the costs of extraction that are incurred by the firm. Since extraction costs are removed from the base of the net-proceeds tax, this tax is the most reflective of the firm's ability to pay.

3.2 Tax Exportation

Taxes levied by one governmental unit can sometimes be "exported" to persons or firms (in their role as buyers of the exported good) located in another governmental unit. Such exporting takes place when persons outside the taxing jurisdiction bear part of the burden of the tax. Tax exporting is likely to occur when a locality can levy a tax on an industry or an activity that sells a significant share of its production to non-residents. Exporting the tax reduces the cost of public services to the residents of the locality because the cost is shared with non-residents who purchase the output. Tax exporting appears to be an empirically significant phenomenon in the United States. Charles McLure, Jr., currently of the National Bureau of Economic Research, has estimated that the average level of tax exporting is high and that it varies significantly among states. The range in 1962 (the last year included in McLure's study) was 15 percent for Maine to 35 percent in Nevada (McLure, 1967). States in which tourism is an important part of economic activity, such as Florida and Nevada, are high export states

because of the ease with which taxes can be shifted to tourists. Other states with concentrations of manufacturing, such as Michigan, export taxes through heavy reliance on corporate income and franchise taxes. The lesson of the McLure study is that almost every state attempts tax exportation via taxation of its unique product. The success achieved depends on the uniqueness and permanence of the taxed activity. Also, it should be noted that tax exportation is not necessarily inequitable. For example, the taxes imposed on tourists in Florida may reflect the social costs of their visits there, including the direct costs such as increased highway maintenance and the indirect costs of decreased environmental amenities available to residents.

Taxation of mineral fuel resources does facilitate exportation of tax burdens to residents located in other states, if the resource is sufficiently distinct from substitute products. If the taxes are borne by non-resident owners of mineral resources or are shifted forward to final consumers located in other states, a state may effectively export a share of its tax burden. The final incidence of mineral fuels taxation and the accompanying degree of exportation depend upon the structure of the supplying industry and the way in which demand for the final product changes in response to changes in prices. A detailed description of tax incidence is provided in Chapter 6.

3.3 Internalization of Social Costs

As discussed in Section 2.1.2, one of the major goals of most taxation structures is to relate taxes paid to benefits received from the public sector. For example, the imposition of taxes on mineral fuels can "defray the costs of mine inspection, pay for reclamation done by the state, and pay for the costs associated with the opening of major new coal developments" (Mortensen, 1977).

However, many of the costs created by resource development are not compensated for by the companies which develop the resources. Such costs might arise from the social and environmental problems that occur as a result of large-scale and rapid development. These costs, referred to by economists as "externalities," are often not reflected in the resource

extraction costs. Accordingly, additional taxes imposed on mineral fuels have been justified in part on the grounds of compensation for the adverse externalities (environmental and social costs) of development.

The ability of each type of mineral fuels tax to compensate for the externalities of development is a function of its revenue-generating capacity and of how well its revenue streams match the environmental and social costs in a given taxing jurisdiction. If compensation for externalities is an objective of the tax structure, the types and mixes of taxes to be imposed become important policy questions. For example, the ad valorem tax appears best suited for generating revenues to alleviate front-end financing problems associated with the social overhead costs imposed during mine construction.[1] Although the per-unit severance tax and the gross-proceeds severance tax may not provide revenues to mitigate the front-end costs imposed by construction-related externalities, once production commences, they nevertheless do generate revenues that may be used to compensate for some of these costs. The net proceeds tax, on the other hand, is not well suited as a means of compensation for external costs. The net-production tax is based on net income, or profits; the mine could be producing (thereby imposing external costs), while net income is zero or even negative. In this case, the taxing jurisdiction would collect no revenues.

For any of these taxation types, a determination of the proper rate of assessment to incorporate social costs is difficult. One must not only match the taxes to the demand for publicly supported impact assistance in the early stages of energy development, but also be cognizant of the uncertainty concerning the eventual social and environmental costs that society will bear in the future. This topic is discussed in Chapter 7.

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[1] Note, the intended purpose of ad valorem taxes almost never includes the matching of external costs due to resource development. Moreover, since determination of the "true" social costs of resource development remains beyond the limits of present economic theory, there is no basis other than political process for establishing what total costs tax revenues must meet.

3.4 Taxation of Economic Rent

Another reason for taxing mineral fuels is to capture a portion of those profits that are in excess of normal returns to business. Economists refer to these excess profits as "economic profits" or "economic rent."

According to the excess profits rationale, an "extraordinary" value of the resources results from the increased demands for the resource by society in the context of a limited supply. The price of the resource rises in response to increased demand, while costs of production do not change. As a result, the private reward from the production of the resource is often far out of proportion to the private investment of capital and skill devoted to production. The state, therefore, may be justified in sharing a portion of the economic rent.

Of the four types of mineral fuels taxes, only the net-production tax is a direct tax on the mine's profits.

3.5 Control Resource Exploitation

A principal reason for the imposition of taxes on mineral fuel resources is to encourage their rational development. The rate at which the firm extracts a mineral deposit is sensitive to the type of tax levied as well as to the rate at which the tax is imposed. Through taxation, the public interest can be served by regulating production to account for any externalities associated with too rapid or too slow a rate of production.

3.5.1 Ad Valorem Tax

As previously mentioned, the ad valorem tax on mineral properties can encourage the firm to accelerate the rate of extraction and thereby reduce future tax liabilities. If the tax is sufficiently large to induce all firms in the industry to increase production and avoid payment of ad valorem taxes, the supply of the mineral commodity will increase. Assuming demand remains constant, the market price of the resource will fall and the quantity of the resource consumed will increase. Imposition of the ad valorem tax, then, could encourage rapid exploitation of the resource.

The tax also raises the cutoff grade of the ore body and reduces the amount of economically feasible ore available, since ore with a quality below the cutoff grade will not be mined. Clearly, from a conservation standpoint, the ad valorem tax does not rate well because it encourages the inefficient use of the resource.

3.5.2 Severance Taxes

Although severance taxes do not encourage rapid depletion of the resource, since the firm cannot "mine out" from under the severance tax, the per-unit and gross-proceeds severance taxes do encourage production high-grading.

3.5.2.1 Per-Unit Severance Tax

The major effect on output created by the per-unit severance tax is production high-grading. The tax increases the firm's average and marginal costs of production. The result is an increase in the price of the resource and a decrease in the quantity produced. Because the firm's costs of producing each additional ton are greater with the per-unit severance tax, ore that was previously marginally profitable to mine may now be unprofitable to extract. In effect, the cutoff grade of profitable ore has increased.

3.5.2.2 Gross-Proceeds Severance Tax

The gross-proceeds tax also encourages high-grading. However, since the tax is levied on the value of the extracted ore, the tax is lower for ores of lower quality. As a result, the reduction in output that results from high-grading under the gross-production severance tax is less severe than under the flat-rate (or per-unit) severance tax.

3.5.2.3 Net-Proceeds Severance Tax

Unlike the per-unit and the gross-proceeds taxes, the net-proceeds severance tax does not restrict output through high-grading. The net-proceeds tax only affects the average costs of production; the marginal cost of mining each ton remains the same as it would be without the tax. The pricing and output decisions of the firm under the net-production

tax are the same as if there were no tax at all. Consequently, the net-production tax is neutral with respect to price and output in the short run; the only effect is to reduce the firm's profits or economic rent.

The differing effects on resource output, resulting from the gross-proceeds and net-proceeds taxes, are illustrated in Figure 3-1. The effects of the gross-proceeds tax are shown in panel A of the diagram. The firm is initially at equilibrium where the incremental cost of producing one additional unit is equal to the incremental revenue to be derived from its sale (P_1Q_1) because profits are at a maximum at this point; that is, marginal cost (MC) equals marginal revenue (MR). The firm produces O Q_1 units and sells them at price O P_1 (the price is determined by the position of the demand curve D at the point Q_1). Imposition of the gross-proceeds tax raises the cost of producing each additional unit of the product. The tax also raises the average cost of producing all units. This is illustrated by the leftward and upward shift of MC and AC to MC' and AC', respectively. The profit-maximizing output and price are now Q2 and P2, respectively, which results from the new equilibrium intersection of MR and MC'.

With the imposition of a net-proceeds tax, however, the marginal cost of producing an additional unit is the same as if there were no tax at all. The tax is effectively a tax on net profits, which is reflected by the upward shift of the average cost curve to AC', as shown in panel B. Both equilibrium price and quantity remain the same as before the tax, but the firm's profits are reduced from their pre-tax levels.[1]

3.6 Administrative Ease

Particular forms of taxes are often imposed by state and local governments because they are easier to administer than others and because they do not cause taxpayer resentment of time-consuming complications. One of the principal reasons for the increase in the number of states imposing

[1] Even in the competitive market model used here, certain firms do accrue profits or economic rents at the equilibrium point, where MC=MR for the marginal firm. These inframarginal rents occur when the supply of factors of production is not perfectly elastic.

severance taxes is the attempt to replace the traditional ad valorem tax, which is difficult to administer, with other taxes that are easier to implement.

3.6.1 Ad Valorem Tax

The ad valorem tax on mineral property is imposed on the owner of the resource. The tax is an assessment against the property at a fixed proportion of the property's value. The typical process of determining the value of a property involves the estimation of the mineral deposit's present value. In most states, surface improvements constitute a portion of the tax base and are subject to the property tax.

The uncertainties under which property value must be determined make accurate assessment extremely difficult. Inaccurate assessment can create inequities of tax liabilities among taxpayers facing similar tax jeopardy, as is discussed above in Section 3.1.5.

3.6.2 Severance Taxes

Severance taxes are easier to administer than are ad valorem taxes. Imposition of severance taxes is usually done with greater certainty about the tax base. The administration of the three types of severance taxes is discussed below.

3.6.2.1 Per-Unit Severance Tax

Of the major types of mineral fuels taxes, the per-unit severance tax is the easiest to administer. Since the tax is levied as a flat rate against volume of output, the tax rate and the number of units extracted (e.g., tons, barrels, cubic feet) are the only information required. Production quantities are usually easy to obtain and to verify from trade sources or from the producing firms and, thus, do not create a compliance burden for the taxpayer.

3.6.2.2 Gross-Proceeds Severance Tax

The gross-proceeds tax is slightly more difficult to administer than the flat-rate severance tax, but easier to administer than the ad valorem tax. In addition to the tax rate, imposition of the gross-proceeds tax

requires knowledge of the gross value of each unit produced. Normally, unit-sales prices are a matter of public record between willing buyers and sellers of mineral resources. However, when transactions are made internally within the same firm, as in the case of a captive mine (i.e., a vertically integrated mining and manufacturing operation), sales price may be more difficult to determine. It may be necessary to use accounting prices, which may not be an accurate reflection of market prices. The investigations required are costly for both the revenue department and the taxpayers.

It should be noted that in several states, including Montana and Wyoming, the basis for the local property tax on mineral resources is the value of gross production. Rather than a true ad valorem property tax, the local property tax imposed in these states is effectively a local severance tax, because it is based on production. This results in a much simpler appraisal process for the local assessors.

3.6.2.3. Net-Proceeds Severance Tax

Of the three forms of severance taxes, the net-proceeds severance tax is the most difficult to administer. Since the tax is levied on net income, in each case it is necessary to obtain information about the firm's production costs and expenses, as well as its gross income. Although the firm's federal income tax returns can be used as the basis for imposing the severance tax, it is still necessary for state revenue officials to verify and check the information filed on federal returns. Besides being costly for the state, it imposes a burden on the productivity of the owner or owning firm that must compile the data necessary for an accurate assessment.

3.7 Intergenerational Transfer

One of the principal characteristics of mineral fuel resources is their exhaustible and non-renewable nature. Once extracted from the earth, these resources are effectively removed forever from consumption by future generations. Resources that occur in nature, as do mineral fuel resources, are felt to be the common heritage of present and future generations. The imposition of taxes on mining firms for the privilege

of extracting mineral fuel resources has been justified on the basis of allowing citizens of the present generation to share in the natural wealth of the state and extending the benefits of the extractable resources to future generations. As stated by Professor Gerald Boyle:

> ... firms depleting natural resources should be subject to normal taxes in business activity, they should also be subject to special taxes on the grounds that they are permanently reducing the wealth of the state. Some part of the wealth should be captured by the state in the form of taxation (Boyle, 1976).

States that have imposed special taxes on mineral fuel resources have usually stipulated the use of revenues generated by the taxes. The mandated uses include a variety of expenditures, such as: the alleviation of local fiscal impacts created by mineral development; the construction of public schools, highways and other facilities; general revenue available to fund services or reduce other types of taxes; revenue to be shared with local governments; or a fund for making loans to local governments.

In addition, many states which tax mineral fuel resources explicitly recognize the common heritage of this and future generations and require that a portion of the revenues generated by mineral fuels taxes be placed in a permanent trust fund. In the Old West Region, the states of Montana and Wyoming have established such funds. It is also felt by some lawmakers that some social costs may not be completely recognized at the present time.

Adverse environmental conditions that arise in the future from present economic activity should be compensated by the producers of the economic good.

Since a principal object of the common heritage argument is the amount of the resource's wealth that will be available to future generations, it appears that resource conservation is an aspect that must be considered when evaluating how well the forms of taxation match the rationale. In this regard, it is noted in Section 3.5 that the ad valorem tax encourages the firm to accelerate the rate of extraction, while the per-unit and gross-proceeds severance taxes reduce the output of the mine.

The net-proceeds tax, on the other hand, does not alter the level of output. Therefore, the per-unit and gross-proceeds severance taxes promote resource conservation and ensure that a greater amount of the resource, albeit a lower grade, will be available for future generations.

4. HISTORICAL DEVELOPMENT OF MINERAL FUELS TAXATION IN THE OLD WEST REGION

4. HISTORICAL DEVELOPMENT OF MINERAL FUELS TAXATION IN THE OLD WEST REGION

In the late 19th and early 20th centuries, mining states were confronted with numerous problems in designing mining tax legislation. Some states declared that only mineral production should be taxed, while others taxed the severed product as personal property, and still others treated mines as ordinary property and taxed them according to the value of the property (Tippit, et al., 1960). Some states exempted mines from taxation altogether.

The ad valorem property tax is generally recognized as the first method used to tax mineral resources in the United States. The ad valorem tax is imposed on the ownership of real property and, historically, has been the primary source of revenue for local governments. The owners of mineral resources, like owners of other forms of property, are assessed a tax based on the value of their property holdings. In the case of mineral properties, however, a major portion of the properties' value is the ore body located beneath the surface.

With the rapid industrialization in the United States during the latter part of the 19th century, a greater appreciation of the exhaustible character of extractive resources emerged across the country. The new sense of conservation, which encouraged the non-use of exhaustible resources in the interests of future generations, led to shifts in public policy regarding resource management.

Clearly, the ad valorem tax on mineral properties seemed an inappropriate way to generate public revenues, since it encouraged resource exploitation, rather than conservation. Furthermore, the ad valorem tax was used principally by local governments, whereas ownership of the resources extended beyond local boundaries. New methods of taxing mineral resources were needed that would: (1) generate ample revenues, (2) promote conservation and the most efficient use of mineral resources, (3) compensate future generations for the irretrievable loss of the resource, and (4) simplify administration.

In 1846, Michigan enacted the nation's first mineral severance tax. The tax was imposed on the privilege of extracting oil and gas. The severance tax was easy to administer; and since it was a variable cost of production, by our arguments under Section 2.2.2, imposition of the tax should have reduced the rate of output and thereby encouraged conservation of the resource deposit. Unfortunately, production data with and without the tax are not available in sufficient detail to determine whether the conservation effect was, in fact, realized.

By 1919, ten states (Michigan, Pennsylvania, Minnesota, Texas, West Virginia, Oklahoma, Louisiana, Kentucky, Alabama, and Colorado) had enacted severance taxes. By 1978, twenty-nine states imposed some form of severance tax. The severance tax is levied in lieu of all other ad valorem taxes in ten of the twenty-nine states. In the remaining nineteen states, some ad valorem tax is imposed at the state and local level (Stinson, 1978). In the Old West Region, the states of Montana, Wyoming, and South Dakota allow local governments to impose property taxes in addition to any state-levied severance taxes.[1] North Dakota exempts oil and gas from local ad valorem taxation, but allows local ad valorem taxation of coal resources.

In the following sections, the historical development of mineral fuels taxation in the five Old West Region states is examined, and the current taxation and revenue allocation systems are described. The reader is also referred to Appendix A which summarizes this information and also contains information about the development of mineral fuels taxation in nine other states of the western United States.

4.1 Montana

Montana has developed a relatively broad set of mineral fuels taxes. These include coal, oil, and natural gas severance taxes (including the Resource Indemnity Trust Tax and the Oil and Gas Conservation Tax) and

[1] It should be noted that the local taxes imposed in Montana and Wyoming are based on the value of production land and, therefore, are not true ad valorem taxes as defined in this paper. Rather, they are locally imposed severance taxes for which the rate in a given year is the same as that applied to other classes of property on which ad valorem taxes are levied. The ore body, itself, however, is not subject to taxation.

property taxes. The coal severance tax is the most important of these in terms of state revenues.

4.1.1 Coal License Tax (Severance Tax)

The first mineral fuel severance tax imposed in Montana was established in 1921. The original law prescribed a license tax on each ton of "merchantable (sic) coal, mined, extracted or produced" at a rate of $.05 per ton (1921 Mont. Laws, Ch. 155). The tax was paid in quarterly installments, due thirty days after the end of each quarter. All receipts from the tax were deposited in the State General Fund.

In 1939, the legislature amended the severance tax law, providing for a 50,000-ton exemption from the tax (1939 Mont. Laws, Ch. 200, Section 1).

In 1967, the law was again amended to limit the tax to strip mines only (1967 Mont. Laws, Ch. 244). The 1967 amendments also authorized a tax credit in the amount of one-half of the reasonable value of reclamation costs (1967 Mont. Laws, Ch. 245).

In 1971, the coal severance tax was further modified. The exemption was lowered from 50,000 tons to 5,000 tons, and the tax was graduated based on the Btu content of the extracted coal[1] (1971 Mont. Laws, Ch. 355). Furthermore, the tax credit was changed so that the amount of the credit would not exceed one cent per ton of coal removed from the reclamation area.

In 1973, the rate schedule was changed significantly,[2] and the reclamation tax credit was removed. In addition, a portion of the receipts from

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[1]The 1971 tax rate schedule imposed was as follows:

Btu/lb	Tax Rate
6,000 or less	$.04/ton
6,001 - 7,500	$.06/ton
7,501 - 9,000	$.08/ton
9,001 and over	$.10/ton

[2]The 1973 rate schedule was as follows:

Btu/lb	Tax Rate
7,000 or less	$.12/ton
7,001 - 8,000	$.22/ton
8,001 - 9,000	$.34/ton
9,001 and over	$.40/ton

the tax ($.01 per ton) was distributed to the county in which the coal was extracted (1973 Mont. Laws, Ch. 432).

In 1974, the county share of coal severance tax receipts was increased from $.01 per ton to $.03 per ton (1974 Mont. Laws, Ch. 250).

The 1975 legislature further modified the license tax on coal and enacted the system for taxing coal that presently exists. The 1975 amendments were enacted to take better account of the differences in cost between strip mining and underground mining, to help stabilize the flow of tax revenues from coal mines to local governments, and to simplify the structure of the coal taxation system in Montana. A new rate schedule was enacted based upon the heating quality of the coal and upon the manner in which the coal was mined. The rate schedule is shown below:

Btu/lb.	Surface Mine	Underground Mine
7,000 or less	$.12/ton or 20% of value	$.05/ton or 3% of value
7,001 - 8,000	$.22/ton or 30% of value	$.08/ton or 4% of value
8,001 - 9,000	$.34/ton or 30% of value	$.10/ton or 4% of value
9,001 and over	$.40/ton or 30% of value	$.12/ton or 4% of value

The 1975 legislature also authorized an annual exemption of 20,000 tons of production.

An extensive revenue distribution program was also enacted by the 1975 legislature to allocate the proceeds collected from the tax. The distribution of revenues from the coal mine severance tax (coal mine producers' license tax) is quoted below.

1. To the county for such purposes as the governing body of that county may determine from which coal was mined for each calendar year prior to 1 January 1980, $.03 per ton or 4 percent of the severance tax paid on the coal mined in that county, whichever is higher, and for each calendar year following 31 December 1979, $.03 per ton or 3.5 percent of the severance tax paid on the coal mined in that county, whichever is higher.

2. Of total collections, 2.5 percent per year until 31 December 1979, and thereafter 4 percent of total collections per year to the earmarked revenue fund, to the credit of the Alternative Energy Research Development and Demonstration account.

3. Of total collections, 27.5 percent per year, until 1 July 1979, and thereafter 35 percent to the earmarked revenue fund to the credit of the Local Impact and Education Trust Fund account.

4. For each of the four fiscal years following the effective date of the Act, 10 percent of total collections per year to the earmarked revenue fund to the credit of the Coal Area Highway Improvement account.

5. Of total collections, 10 percent per year, to the State School Equalization Fund, for state equalization aid to public schools of the state.

6. For the period ending 31 December 1979, 1 percent of total collections per year to the earmarked revenue fund, to the credit of the County Land Planning account.

7. Of total collections, 2.5 percent per year through 30 June 1979, of which portion ½ shall be allocated to the earmarked revenue fund, for the purpose of acquisition of sites and areas described in Section 62-304 (dealing with parks), subject to legislative appropriations, and ½ shall be allocated to the Trust and Legacy Fund, for the purpose of parks acquisition. After 30 June 1979, 5 percent of total collections per year shall be allocated to the Trust and Legacy Fund, for the purpose of parks acquisition. Income from the fund established in this subsection may be appropriated for the acquisition of sites and areas described in Section 62-304.

8. To the earmarked revenue fund, such portions of the severance tax as may be authorized by laws enacted in 1975.

9. All other revenues from license or severance taxes collected under the provisions of this chapter shall be deposited to the credit of the General Fund of the State (Real Estate Research Corporation, 1977).

The 1979 legislature allocated 0.5 percent per year of total collections to the State Library Fund.

Coal severance tax revenues totalled $34.372 million in FY 1978, up from $23.934 million in 1976 and $3.306 in 1974 (Montana Office of the Legislative Fiscal Analyst, 1979). This was the equivalent of $1.31 per ton in FY 1978. In 1978, coal taxes accounted for 10.8 percent and 4.3 percent of Montana's total tax and state revenues, respectively. One-third of coal tax revenues went to the state's General Fund, where they represented 5.5 percent of the total. Table 4-1 presents the projected levels and distribution of coal severance taxes over the FY 1979 to FY 1981 period.

TABLE 4-1

Projected Level and Distribution of Coal Tax Revenues:
1979-81
(thousands of dollars)

Category	Fiscal Year		
	1979	1980	1981
General Fund	$12,004	$13,137	$10,720
Constitutional Trust Fund	10,003	14,399	27,487
Local Coal Impact Fund	5,061	5,749	4,810
Ed. Trust	2,892	5,642	5,497
Coal Area Highways	3,901	1,253	-
Public School Equalization	3,001	3,320	2,749
Renewable Resources	750	830	687
Alternative Energy	750	955	1,374
Coal Producing Counties	600	564	-
Site Acquisition	375	120	-
Parks Acquisition	375	1,298	1,374
County Land Planning	300	332	275
TOTAL	$40,012	$47,599	$54,973

Source: Montana Office of the Legislative Fiscal Analyst, Budget Analysis: 1981 Biennium, Helena, 1979.

4.1.2 Oil and Gas Severance Tax

In 1921, the state of Montana enacted a tax of one percent on the total gross value of petroleum and other mineral or crude oil produced in the state (1921 Mont. Laws, Ch. 266). In 1923, the tax rate on the gross value of oil production was increased to 2 percent (1923 Mont. Laws, Ch. 67). In 1957, the tax rate was changed to 2 percent on the gross value from the first 450 barrels of production from each well in each calendar quarter, and to 2.5 percent of the value of each barrel in excess of 450 barrels (1957 Mont. Laws, Ch. 221).

In 1969, the rates were raised to 2.5 percent of the value of the first 450 barrels from each well in each calendar quarter and to 2.65 percent of each barrel thereafter (1969 Mont. Laws, Ch. 359). The severance tax was extended to natural gas in 1975 at a rate of 2.65 percent of gross value of production (1975 Mont. Laws, Ch. 245) and thereby replaced the natural gas distributor's tax that was enacted in 1933.

Severance taxes on oil and gas production amounted to $8.235 million in FY 1978, up from $7.649 million the previous year (Montana Department of Administration, 1979). These collections represented 2.7 percent and 1.1 percent of tax revenues and total state revenues, respectively in FY 1978. Approximately 94 percent of these receipts went into the General Fund. Extrapolating from projections of the Legislative Fiscal Anaylst for the 1981 Biennium, oil and gas severance tax revenues are estimated to be:

FY	Revenues (thousands)
1979	$8,478
1980	8,632
1981	8,602

4.1.3 Resource Indemnity Trust Tax

The resource indemnity trust tax is a general tax imposed on all mining or mineral extraction businesses in the state. The tax, established in 1973, is levied at $25 plus 0.5 percent of the total gross value of production (1973 Mont. Laws, Ch. 497, Sections 1-13). The resource indemnity trust tax is levied in addition to the coal, oil, and gas severance taxes.

In FY 1978, the Resource Indemnity Trust Tax amounted to $2.246 million. Of this total, receipts from coal represented approximately $0.573 million, and are projected at over $900,000 in FY 1981.

4.1.4 Oil and Gas Conservation Tax

In 1953, the Montana legislature enacted a per-unit tax on oil and natural gas to be used to defray the expenses of the Oil and Gas Conservation Commission (1953 Mont. Laws, Ch. 238, Section 22). The

original 1953 law established the tax rates at $.0025 per barrel on petroleum from wells producing an average of twenty-five barrels or less per day, and at $.005 per barrel of petroleum from wells producing more than twenty-five barrels per day. The tax rate for natural gas production was established at one mill per 10,000 cubic feet.

In 1961, the law was changed to allow the Oil and Gas Conservation Commission to set the rate, with the original rates established as a ceiling (1961 Mont. Laws, Ch. 47).

In 1973, the limits of the tax rate were changed to $.00375 and $.0075 for petroleum, to 2.5 mills per 10,000 cubic feet of gas, when such gas is marketed for $.15 per 1,000 feet or less, and to 5 mills per 10,000 cubic feet on all other gas (1973 Mont. Laws, Ch. 315).

In 1977, the rate limits were again changed. The 1977 amendment changed the limit to 0.2 percent of gross value of each barrel of petroleum and of each 10,000 cubic feet of natural gas produced (1977 Mont. Laws, Ch. 178). Total receipts in FY 1978 were approximately $500,000.

4.1.5 Property Taxes

Local governments in Montana are also authorized to levy property taxes on mineral resources. These taxes are not ad valorem taxes, as that term has been defined in this paper, since gross proceeds are used to measure the value of coal mines, while net proceeds is used to measure the value of other types of mines. Revenues from this source totalled approximately $ 32 million in FY 1978.

4.1.6 Summary

Mineral fuels taxes play an important -- although not dominant -- role in Montana's revenue picture. Excluding property taxes, levies on mineral fuels accounted for 14.2 percent and 5.7 percent of FY 1978 state tax and total state revenues, respectively. An approximate breakdown of these taxes is:

Type of Tax	Amount (Millions)	% of Total
Severance Taxes		
Coal	$34.37	76
Oil & Gas	8.24	18
Resource Indemnity Trust	2.25	5
Oil & Gas Conservation	.50	1
TOTAL	$45.36	100%

4.2 Nebraska

In 1955, Nebraska enacted a gross production severance tax on oil and natural gas. The tax, in effect today, is imposed at a rate of 2 percent (1955 Neb. Laws, Ch. 219, Section 3).

Tax collections are distributed to the Severance Tax Administration Fund to cover the costs of administration. The remainder is placed in the Permanent School Fund. Total FY 1978 severance tax collections were $1.242 million, representing 0.2 percent and 0.2 percent of state tax and total revenues, respectively.

4.3 North Dakota

The first tax on mineral fuels production in North Dakota was a tax imposed in 1937 on the net earnings of petroleum property. The tax was imposed in lieu of *ad valorem* taxes (1937 N.D. Sess. Laws, Ch. 250). Since that time, the original tax has been changed to a gross value base and additional taxes have been imposed on coal as well as on coal conversion facilities. In spite of the recent rapid expansion of coal production, oil and natural gas severance taxes have continued to account for the largest share of North Dakota's mineral fuels tax revenues.

4.3.1 Oil and Gas Severance Tax

From the net earnings base established for petroleum property in 1937, the severance tax base was changed in 1953 to gross value of oil and natural gas at the well (1953 N.D. Sess. Laws, Ch. 339, Sections 2 and 3). The tax rate of 4.5 percent in 1953 was increased in 1957 to

5 percent (1957 N.D. Sess. Laws, Ch. 368). Total receipts from this tax were $13.533 million in FY 1979, an increase of 26 percent over the previous year. For purposes of comparison, these revenues were approximately 5.4 percent of FY 1979 General Fund collections.

4.3.2 Coal Severance Tax

In 1975, North Dakota instituted a quarterly per-unit severance tax on coal extracted in the state. The original law established the tax rate at $.50 per ton, with an escalator of $.01 per ton for every increase of three percentage points in the Wholesale Price Index from its June 1975 level (1975 N.D. Sess. Laws, Ch. 563).

The original 1975 coal severance tax was effective for a two-year period and was replaced in 1977 with another two-year tax. The 1977 tax law increased the tax rate to $.65 per ton, plus an additional $.01 per ton for each percentage point increase in the Wholesale Price Index from its June 1977 base (1977 N.D. Sess. Laws, Ch. 560). The tax rate was $.88 per ton in the first quarter of 1979 and $.97 per ton during the second quarter. The 1979 legislature cut the rate to $.85 and reduced the escalator to a $.01 per ton increase for every four point rise in the Wholesale Price Index, effective 1 July 1979.

The revenue generated from the North Dakota coal severance tax is deposited in the state coal development fund. Funds deposited in the coal development fund are apportioned as follows:

1. Thirty-five percent of the funds ($4.2 million in FY 1979) is credited to a special fund for distribution through grants by the Coal Development Impact Office to affected cities, counties, school districts, and other taxing districts. Funds available are limited to the amount appropriated biennially by the legislature.

2. Fifteen percent of the revenue ($1.8 million during FY 1979) is credited to a special fund to be held in trust by the State Treasury and to be administered by the Board of University and School Lands. This fund is available for loans to affected units of local government. Before making a loan, however, the Board of University and School Lands must receive the recommendation of the Coal Development Impact Office. The board has the power to prescribe the terms and conditions of these loans, and it requires a warrant from the unit of local government as

evidence of the loan. The warrants bear interest at a rate not exceeding 6 percent and are payable only from money allocated from the Coal Development Fund to the borrower. The warrants are not considered a general obligation of the local government, nor are they considered as indebtedness of the unit of government. If the future allocation of money to the borrowing unit of government ceases, the loan will be canceled.

Funds not loaned may be invested by the Board of University and School Lands as provided by law. The income, including interest payments on loans, is deposited in the State's General Fund. Loan principal payments are redeposited in the Trust Fund.

3. Twenty percent of the revenue ($2.4 million during FY 1979) is allocated to the coal producing counties in proportion to the number of tons of coal produced in each county. Within the county, the allocation is distributed as follows:

   a. Thirty percent to incorporated cities of the county based upon the population of each city,

   b. Forty percent to the county government, and

   c. Thirty percent to school districts in the county, apportioned on an average daily enrollment basis.

4. Thirty percent of the revenue ($3.6 million in FY 1979) is deposited in the state's General Fund.

Total coal severance tax revenues were $7.856 million and $11.97 million in FY 1978 and 1979, respectively. The increase between the two years was 52 percent. FY 1979 coal severance tax revenues were equivalent to about 5 percent of General Fund collections.

The same act created a Coal Development Impact Office, with a director appointed by the governor. The office is empowered to develop a plan to provide financial assistance to local governments in coal development impact areas, to study and report to the governor and to the legislature on the impact of coal development on local government, to establish procedures and provide proper forms for use in making application for funds for impact assistance, and to make grants to counties, cities, and school districts, and other taxing districts. In determining the size of the grant for which a political subdivision is eligible, that revenue is considered which the local government will receive from taxes on the real property of coal development plants and from other tax or fund distribution (1977 N.D. Sess. Laws, Ch. 563, Section 14.4).

4.3.3 Coal Conversion Facilities Tax

A tax on coal conversion facilities was also enacted by North Dakota in 1975. The tax is in lieu of the ad valorem tax on the real property, but not on the land on which the facility is located.

The tax is levied at a rate of 2.5 percent of gross receipts for facilities other than gasification or electrical generating plants. Gasification plants are taxed at $.10 per 1,000 cubic feet of gas produced, or 2.5 percent of gross receipts, whichever is greater. For electrical generating plants, the tax is 0.25 mill per kilowatt hour produced. Total collections from this tax increased 17 percent from FY 1978 to FY 1979, to $2.237 million.

Sixty-five percent of the proceeds from the coal conversion tax in each facility is apportioned to the state's General Fund, and the remainder goes to the county in which the plant is located. The county share ($783,000 in FY 1979) is further allocated to local governments as follows:

1. Thirty percent is divided among all incorporated cities in the county, according to the population of each as shown by the last regular or special census.
2. Forty percent is deposited in the county's General Fund.
3. Thirty percent is divided among all school districts in the county on the basis of average daily enrollment.

4.3.4 Summary

Mineral fuels tax revenues in North Dakota totalled $27.74 million during FY 1979, a 35 percent increase over the previous year. Together, they contributed approximately $18.6 million or 7.4 percent to the state's General Fund. The 1979 breakdown by revenue source was:

Type of Tax	Amount (millions)	% of Total
Oil and Gas Severance	$13.53	49%
Coal Severance	11.970	43
Coal Conversion Facilities	2.24	8
TOTAL	$27.74	100%

4.4 South Dakota

In 1975, the South Dakota legislature approved a license tax on the privilege of mining or extracting mineral products in the state. The tax was imposed at a rate of 4 percent on net profits from the production of coal, uranium, petroleum, oil, or natural gas. The original law provided an exemption for persons extracting minerals worth less than $100,000 (1975 S.D. Sess. Laws, Ch. 110).

In 1977, the legislature authorized a 3 percent severance tax on the gross value of oil and gas, and exempted oil and gas production from the 4 percent net profits tax (1977 S.D. Sess. Laws, Ch. 93).

In 1978, the severance tax rate was increased to 4 percent of gross value and was extended to coal and uranium production (1978 S.D. Sess. Laws, Ch. 81). The tax is in lieu of the license tax on the privilege of mining in the state, as well as all other taxes except sales, use, and property taxes. The severance tax is currently 4.5 percent, distributed 50 percent to the counties in which the minerals were severed and 50 percent to the state treasury. Of the state's share which was raised from one-third by the 1979 legislature, the first one million dollars are earmarked for the newly established Energy Development Impact Fund.

Total severance tax collections for mineral fuels in FY 1979 were $.457 million, and a relatively insignificant 0.1 percent of total tax collections. South Dakota's energy severance tax revenues are derived almost entirely from oil and gas production.

4.5 Wyoming

Wyoming's first tax on the production of mineral fuel resources was established in 1953 on the production of oil and natural gas. The Oil and Gas Conservation Commission was given the authority to establish a tax not to exceed .4 of one mill per one dollar of the gross value of production (1953 Wyo. Sess. Laws, Ch. 88). Since that time, the tax has been extended to other mineral fuels and modified repeatedly. Other mineral fuels taxes of note are ad valorem and sales/use taxes.

4.5.1 Severance Taxes

In 1969, the state legislature enacted a severance tax of 6.25 percent of the gross value for production of coal, trona, uranium, petroleum, or other crude mineral oil or natural gas or other valuable deposits (1969 Wyo. Sess. Laws, Ch. 193).

In 1974, the severance tax was changed to reflect a split tax rate for non-fossil minerals and fossil fuels. Uranium and non-fossil fuel minerals were taxed at one percent of gross value, while fossil fuels were taxed at 3 percent of gross value.

In 1975, the tax rates were changed again. The original severance tax statute was modified to be a severance tax on coal. The legislature also created a mineral excise tax. In 1975, the coal severance tax was established with an increasing rate for minerals produced from 1974 thoough 1978. The tax, levied on the gross value of coal produced, was established as follows:

Year	Rate
1974	0.4%
1975	0.8%
1976	1.2%
1977	1.6%
1978 and future years	2.0%

In addition, the coal severance tax was to expire when total collections from the tax reached $120 million. Receipts were deposited in the Impact Tax Revenue Account, administered by the Farm Loan Board, to assist areas affected by coal production.

In 1975, amendments also created the mineral excise tax as follows:

a. Two percent of gross value for production of uranium. Receipts are deposited in the State General Fund.

b. Two percent of gross value for production of trona, coal, petroleum, natural gas, oil shale or any other fossil fuel. Receipts are deposited in the Permanent Mineral Trust Fund.

c. Two percent of gross value for production of trona, coal, petroleum, natural gas, oil shale or any other fossil fuel. Receipts are deposited in the State General Fund (1975 Wyo. Sess. Laws, Ch. 125, Section 1).

In 1977, several changes were made in the mining excise tax and the coal severance tax. The mining excise tax was changed to six separate levies on mineral production as follows (1977 Wyo. Sess. Laws, Ch. 189):

a. Two percent of the value of the gross product for uranium, trona, coal, petroleum, natural gas, oil shale, or any other fossil fuel. Receipts are deposited in the Permanent Mineral Trust Fund.

b. Two percent of the gross product value "upon the privilege of severing or extracting any valuable deposit in the state" except production from oil and gas stripper wells.

c. One and one-half percent of the gross value of coal extracted. Receipts are deposited in the Water Development Account until the account reaches $100 million; receipts thereafter will be deposited in the state General Fund, except when needed to replenish the Water Development Account.

d. One percent on coal. Receipts are deposited in the State Highway Fund.

e. One-half percent on coal, uranium, and trona. Receipts are deposited in the Capital Facilities Account. The tax will expire on 1 January following the year in which the taxes collected total $250 million.

f. One and one-half percent on coal, uranium, and trona. Receipts are deposited in the Capital Facilities Account. The tax will expire on 1 January following the year in which the taxes collected total $250 million.

The 1975 amendments also changed the limit for collections for the coal severance tax to $160 million, from the previous ceiling of $120 million (1977 Wyo. Sess. Laws, Ch. 189). As of 1979, the total gross value tax implications of these provisions for severance and mineral excise taxes were:

Mineral	Tax Rate (%)
Coal	10.5
Uranium	5.5
Trona	5.5
Oil and Natural Gas (except stripper wells)	4.0
All others (including stripper wells)	2.0

Wyoming's mineral fuels tax revenues are the largest of the Old West states. In FY 1979, mineral fuels severance taxes totalled $100.131 million, or approximately 12.4 percent of total state income from all sources. This was an increase of 23 percent over FY '78. The relative shares of each fuel are given below:

Fuel	Severance Tax Receipts (millions)	Percent Of Total
Oil	$ 41.211	41.2
Coal	42.935	42.8
Natural Gas	10.576	10.6
Uranium	4.026	4.0
Stripper Well Oil	1.383	1.4
TOTAL	$100.131	100.0

Source: Wyoming Department of Revenue and Taxation

4.5.2 Ad Valorem Taxes

Ad valorem taxes are imposed by local governments in Wyoming on the production value of mineral fuel properties. These, in effect, are local gross proceeds taxes and are significant revenue generators, totalling $115.649 during FY 1979. The sources of this revenue were:

Fuel	Ad Valorem Tax Receipts (millions)	Percent Of Total
Oil	$ 65.641	56.7
Coal	23.703	20.5
Natural Gas	16.952	14.7
Uranium	4.948	4.3
Stripper Wells	4.405	3.8
TOTAL	$115.649	100.0

Source: Wyoming Department of Revenue and Taxation

4.5.3 Sales and Use Taxes

While not nearly as important to state revenues as severance and ad valorem taxes on mineral fuels, sales and use taxes imposed on mining and related activities totalled approximately $9.24 million in FY 1978 (Wyoming DEPAD, 1979).

4.5.4 Summary

Severance and ad valorem taxes on mineral fuels totaled $215.79 million in FY 1979, up 20 percent over FY 1978 collections of $180.41 million. Together, these two revenue sources accounted for nearly 27 percent of total state income from all sources. On coal, the two taxes averaged a rate of approximately $1.18 per ton in FY 1979 versus $1.10 in FY 1978 (Wyo. DEPAD, 1979). The breakdown of these taxes in FY 1979 was:

Type of Tax	Amount (millions)	% of Total
Severance		
Oil and Gas	$ 87.00	40%
Coal	23.70	11
Uranium	4.95	2
Ad Valorem		
Oil and Gas	53.17	25
Coal	42.94	20
Uranium	4.03	2
TOTAL	$215.79	100%

Oil and natural gas dominate Wyoming's mineral fuels tax receipts with approximately 65 percent of the total. Coal is a distant second with 31 percent and uranium even farther back at 4 percent.

4.6 Tax Impacts on Price

To the extent that market structure or institutional arrangements permit mineral fuels taxes to be 100 percent incorporated in the prices of the fuels, the effect on delivered price is easily determined. However, as we shall see in Chapter 6, the true effect on price is not always a simple question. Moreover, the meaning of price itself requires further discussion if meaningful comparisons among various states' mineral fuel taxes are to be made. This is due to the qualitative differences that exist within any fuel cataegory.

Comparing the ultimate levels of taxation for a fuel such as coal requires specifying the characteristics of that fuel in common terms. For example, it is misleading to state that North Dakota's severance tax of 87 cents per ton[1] of coal is less than Montana's tax of 137 cents per ton[1] of coal, because the "tons" are of different average quality.

[1] FY 1979 averages

Since both North Dakota and Montana coal are primarily used for electric power generation, the Btu content per ton is a more meaningful basis of comparison. Based upon mines currently in operation, the average Btu content of North Dakota coal was 6,750/lb., while that of Montana was 8,950 Btu/lb., and Wyoming was 8,050/lb.[1] On a million Btu basis, the average severance tax burden in Old West coal producing states is: Montana, 7.3 cents; North Dakota, 6.5 cents; and, Wyoming, 4.7 cents.

This comparison can be extended to other fuels and other states. Table 4-2 compares the severance tax burden for six states and three fuels. It is readily apparent that, on a per million Btu basis, Montana, North Dakota, and Wyoming's severance taxes are lower than those of both Louisiana and Oklahoma, while only Montana's coal severance tax is higher than Texas' oil and natural gas taxes, and natural gas taxes in Oklahoma and Louisiana.

TABLE 4-2

Severance Tax Burden on Coal, Oil, and Natural Gas Production for Six States
(¢ per million Btu's)

Fuel	State					
	Montana	North Dakota	Wyoming	Texas	Louisiana	Oklahoma
Coal	7.3	6.5	4.7			
Oil	4.1	7.0	5.4	6.6	16.6	12.6
N. Gas	2.1	2.1	3.2	6.2	6.9	6.0

Source: Comptroller of Public Accounts, State of Texas (1978), and Mountain West Research, Inc., estimated from 1978 production and tax receipts.

This comparison is still somewhat misleading in that it does not take into account the differential efficiencies with which these fuels can be converted into end products (i.e., electricity). For example,

[1] Extrapolated from mine production and coal quality data found in the Fact Book for Western Coal/Energy Development, prepared by Mountain West Research, Inc., for the Western Coal Planning Assistance Project; Billings, 1979.

coal is slightly more efficient than either oil or natural gas in generating electrical energy.[1]

In Chapter 6, an analysis of the probable direction and magnitude of tax shifting for the case of coal is undertaken. There is substantial theoretical and empirical evidence that taxes on exported coal in the Old West Region are also almost entirely exported. Assuming, therefore, that coal taxes are 100 percent exported to the ultimate electric power consumer, what proportion of the delivered price of coal do such taxes represent?

Based upon monthly reports regarding the "Cost and Quality of Fuels for Electric Utility Plants" (U.S. Department of Energy; October, 1978 and August, 1979), the cost of coal delivered to steam-electric generating plants averaged $1.201 per million Btu's in April 1979, up 8.3 percent over the previous year. Table 4-3 presents the comparable data for selected states and power plants. Low sulfur (less than 0.5 percent) coal prices are shown since there is a greater likelihood of these prices representing deliveries of Old West coal. Per million Btu, Montana severance taxes would account for 23 percent of April 1979 delivered price in Montana, 4 percent in Illinois (5 percent at the Waukegan plant of Commonwealth Edison), 8 percent in Minnesota, 7 percent in Wisconsin, and 5 percent in Michigan. Similarly, Wyoming severance taxes would account for 3 percent of delivered price in Illinois, 3 percent in Michigan, and 6 percent in Texas. North Dakota's severance tax represents 14 percent of the average in-state delivered coal price.[2]

Taking a particular case as an example, Colstrip #1 saw its coal costs increase 13.5 percent during the twelve-month period ending April 1979. The Western Energy Company also ships coal from Colstrip to

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[1] Conversion efficiencies are: coal, 37 percent; oil, 34 percent; and, gas, 36 percent. Energy Economics. Stanford Research Institute, Menlo Park, California.

[2] For purposes of comparison, the Louisiana severance tax on oil in April, 1978, represented about 9 percent of the delivered in-state fuel oil price.

TABLE 4-3

Delivered Price of Coal to Steam-Electric Power Plants
Selected State and Plant Averages for Low Sulfur Coal
(April 1978 and April 1979)

State or Power Plant	Price (cents per million Btu's)		% Change 4/78-4/79
	April 1978	April 1979	
Montana	26.6	32.1	+21
Wyoming	36.4	63.9[a]	+76
North Dakota	36.0	46.3	+29
Illinois	142.6	173.3	+22
Minnesota	71.9	94.5	+31
Wisconsin	86.9	107.0	+23
Michigan	138.1	159.0	+15
Texas	58.0	85.2	+47
Colstrip #1 (Colstrip, MT)	26.6	30.2	+13.5
Jim Bridger (Rock Springs, WY)	34.3	39.3	+14.6
Stanton (Stanton, N.D.)	71.0	66.3	- 6.6
Waukegan (Waukegan, Ill.)	116.0	140.9	+21

[a]Price distorted by very high reported prices at Wyodak.

Source: U.S. Department of Energy, Energy Information Administration, "Monthly Report: Cost and Quality of Fuels for Electric Utility Plants", April 1978 and April 1979, Washington, D.C.

Commonwealth Edison's Waukegan plant in Illinois. There, delivered price increased 21 percent over the same twelve-month period. Assuming the quality of the coal shipped was approximately the same in April 1979 as in April 1978, and that the Waukegan price is for Montana coal, the difference in price increase between Colstrip #1 and the Waukegan plant would be almost entirely due to increases in transportation charges. The total difference, 21.3 cents per million Btu is almost three times the Montana severance tax, and would be the equivalent of an 18 percent increase in delivered price.

5. MINERAL FUELS INDUSTRIES IN THE OLD WEST REGION

5. MINERAL FUELS INDUSTRIES IN THE OLD WEST REGION

5.1 Oil and Gas

5.1.1 Historical Development

In the postwar period, the oil and gas industry in the Old West Region has generally exhibited the same characteristics as the industry in the U.S. as a whole: a surge in exploration in the 1950s and early 1960s following the development of modern seismic techniques, an associated increase in reserves and production as new discoveries were developed, and production beginning to decline when additions to capacity became less than the reduction in capacity from existing wells.

5.1.1.1 Petroleum

In 1940, the Old West Region produced 2.5 percent (33,513 thousand bbls.) of the nation's petroleum. Over three-quarters of this production was in Wyoming. By 1950, the Region's production had more than doubled, to 71,287 thousand bbls, (3.6 percent of the national total), with nearly all of the increase in Wyoming. During the 1950s, production expanded greatly in all of the Old West states except South Dakota; and in 1960 the Region produced 212,143 thousand bbls, 8.2 percent of total U.S. production. By 1970, even though production increased 9 percent over the decade, the Old West share of total production had declined to 6.6 percent. Table 5-1 traces the historical development of petroleum production in the Old West states and in the U.S. as a whole.

5.1.1.2 Natural Gas

The Old West Region produced 2 percent (49,792 mmcf) of the nation's natural gas in 1940. This production was almost equally divided between Montana and Wyoming. By 1950, production had more than doubled in Wyoming, nearly doubled in Montana, and been

TABLE 5-1

Crude Petroleum Production in the Old West Region and in the United States
(thousands of 42-gallon barrels)

	U.S.	MT	NB	ND	SD	WY	OWR TOTAL
1940	1,353,214	7,526	276	-	-	25,711	33,513
1950	1,973,574	8,109	1,547	-	-	61,631	71,287
1960	2,574,933	30,240	24,428	21,954	-	135,521	212,143
1970	3,517,450	37,879	11,451	21,998	160	160,345	231,833
1971	3,453,914	34,599	10,062	21,653	233	148,114	214,621
1972	3,455,368	33,904	8,705	20,624	219	140,011	203,463
1973	3,360,903	34,620	7,240	20,235	275	141,914	204,284
1974	3,202,585	34,554	6,611	19,697	494	139,997	201,353
1975	3,056,779	32,844	6,120	20,452	472	135,943	195,831
1976	2,976,180	32,814	6,182	21,725	447	134,149	195,317
1977	3,000,265	32,680	5,968	23,273	632	136,472	199,025
1978[a]	3,175,927	30,431	5,859	24,779	863	136,798	198,730

[a] Preliminary

Source: U.S. Bureau of Mines, Minerals Yearbook, various years from 1960 through 1976; unpublished data for 1977 and 1978 from Division of Oil and Gas Statistics, Energy Information Administration, U.S. Department of Energy.

initiated in North Dakota and Nebraska. Despite the increase in production, to 101,873 mmcf, the region's share of national production declined somewhat, to 1.6 percent, as reserves and production were added even more rapidly in other states. During the 1950s, the Old West Region's share of national production rebounded and, in 1960, accounted for just under 2 percent (249,769 mmcf) of the U.S. total. National production increased by 25 percent during that same decade. However, by 1970, the Region's share had declined slightly to 1.9 percent despite a 69 percent increase in production, to 422,105 mmcf. Table 5-2 presents natural gas production figures for the Region and the U.S. from 1940 to 1978.

5.1.2 Renewed Demand in the 1970s

The renewed interest in oil and gas in the Old West Region and, indeed, in the world, obviously stems from the Arab boycott of 1973 and subsequent quadrupling of crude prices by the Organization of Petroleum Exporting Countries (OPEC). Since then of course, OPEC, as world price leader, has increased prices several times while political instability in Iran resulted in significant interruption in world output last year. One might reasonably anticipate future interruptions as many of the oil producing states seem vulnerable to political instability and unrest.

5.1.2.1 Petroleum

Despite this renewed interest in (increased demand for) Old West resources, the Region's petroleum production declined erratically until 1976 when 195,317 thousand bbls were produced. However, the Region's percentage of national production has been rising since 1972, reflecting the fact that Old West states' production has not been declining as rapidly as production in other regions.

Since the largest and most accessible reserves have already been located and significantly exploited, new production has come primarily from less accessible and/or smaller reservoirs. Thus, it is not surprising that the increases in production experienced in the late

TABLE 5-2

Natural Gas Production in the Old West Region and in the United States
(millions of cubic feet)

	U.S.	MT	NB	ND	SD	WY	OWR TOTAL
1940	2,476,756	23,178	-	-	-	26,614	49,792
1950	6,282,060	39,186	17	608	-	62,062	101,873
1960	12,771,038	33,418	15,258	19,483	-	181,610	249,769
1970	21,920,642	42,705	5,991	34,889	-	338,520	422,105
1971	22,473,012	32,720	3,496	33,864	-	380,105	450,185
1972	22,531,698	33,474	3,478	32,472	-	375,059	444,483
1973	22,647,549	56,175	3,836	27,703	-	357,731	445,445
1974	21,600,522	54,873	2,538	31,206	-	326,657	415,274
1975	20,108,661	40,734	2,565	24,786	-	316,123	384,208
1976	19,952,435	42,563	2,511	31,470	-	328,768	405,312
1977	20,025,463	46,819	2,789	29,173	-	330,180	408,961

Source: U.S. Bureau of Mines, Minerals Yearbook, various years from 1960 through 1975; "Natural Gas Production and Consumption," Energy Data Reports, Energy Information Administration, U.S. Department of Energy, 1976 and 1977.

seventies have been slow to develop. In fact, production has been relatively static during that period.

There have been significant increases in the number of wells drilled in all of the Old West states since 1973. The increases have been in both development wells (drilled in producing areas) and in exploration wells (drilled in more speculative areas). Table 5-3 highlights drilling activities in the Old West states since 1970. This increased activity has obviously been precipitated by the increase in the world price of oil during that period. In fact, since increased exploration and development have been taking place nationwide, the principal constraint on drilling activity in the Old West Region has been the availability of drilling rigs.

5.1.2.2 Natural Gas

The Region's experience with natural gas production continued to approximately parallel that of petroleum. Production peaked at 450,185 mmcf in 1971 and declined to 348,208 mmcf in 1975 (1.9 percent of the nation's total).

Since then, production has increased; but even so, 1977's 408,961 mmcf was only 91 percent of 1971 production. However, the Old West Region's resurgence as a natural gas supplier has been more rapid than the national average, resulting in the Region's share of production increasing to 2.04 percent.

5.1.3 Future Demand for Old West Petroleum and Natural Gas Resources

5.1.3.1 Petroleum

There seems to be very little doubt that in the foreseeable future producers of petroleum in the Old West states will be able to sell all the crude they can produce. The more important issue concerns the response of suppliers to price decontrol and changes in taxation. These factors strongly influence producers' profitability expectations and, consequently, the levels of exploration.

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Source: U.S. Bureau of Mines, Minerals Yearbook, various years from 1960 through 1975; "Natural Gas Production and Consumption," Energy Data Reports, Energy Information Administration, U.S. Department of Energy, 1976 and 1977.

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TABLE 5-3

Oil and Gas Well Drilling in the Old West Region

	MT		NB		ND		SD		WY	
	Wells	Footage	Wells	Footage	Wells	Footage	Wells	Footage	Wells	Footage
1970	603	2,447,497	237	1,193,210	167	1,047,848	83	270,534	1,399	9,917,834
1971	427	1,656,624	187	905,512	162	972,477	35	125,937	893	5,325,999
1972	753	2,357,974	292	1,407,668	99	654,230	36	161,899	964	6,506,110
1973	642	1,848,470	163	829,315	122	853,697	22	102,099	885	5,767,495
1974	742	2,173,519	230	1,189,152	127	947,713	17	86,046	988	6,692,202
1975	845	2,467,833	338	1,707,170	202	NA	27	144,364	1,263	8,936,454
1976	674	2,386,874	323	1,590,139	234	1,718,958	32	177,772	975	6,965,526
1977	761	2,811,142	424	2,069,596	225	1,685,395	41	311,351	1,307	9,519,776
1978	673	2,623,082	384	1,919,573	327	2,746,658	45	339,402	1,395	9,716,720

Source: U.S. Bureau of Mines, various years from 1970 through 1975; American Petroleum Institute, Quarterly Review of Drilling Statistics, Annual Summary, 1976, 1977, and 1978.

Projecting the production of oil and gas is difficult because discovery by drilling a well is the same device used for production; that is, it is generally not possible to gain knowledge about the existence of a reservoir without creating the facility for extracting the resource. This is quite different from nearly every other natural resource where the discovery of the ore body, forest, or whatever can be accomplished without creating a mine, sawmill, or other extractive facility. The degree of uncertainty in oil and gas production is such that development wells, drilled to exploit "discovered" reserves are frequently dry. Given the difficulty of projection, one can view with appropriate skepticism the National Petroleum Council estimates that in its Region 4 (the region most closely approximating the Old West Region[1]), there are ultimate discoverable reserves of 52.4 billion barrels, of which 23.9 billion have already been discovered (National Petroleum Council, 1972). However, this reserve estimate is the "median (expectable) estimate." It should be kept in mind that estimates of the "ultimate discoverable reserves" of the 48 continguous states range from 516 billion barrels to 1,519 billion barrels (National Petroleum Council, 1972). Production will obviously depend on the existence and discovery of these reserves. The willingness of producers to explore for oil and gas will depend on, among other things, the price of oil and gas. As recent experience has shown, accurately forecasting oil and gas prices is virtually impossible.

Table 5-4 presents the Project Independence (Project Independence, 1974) estimates of oil production for Region 4 under "business as usual" and accelerated effort assumptions, with crude oil prices at $4, $7, and $11 per barrel. The importance of both price and regulatory environment are illustrated in this table. Were the U.S. price to have remained controlled at $4 per barrel, the production decline of the early 1970s would have continued even with an "accelerated" development program. Production would have declined from 400,000 bbls/day in 1980 to 235,000 bbls/day in 1988 with no policy change, and to 236,000 bbls/day

[1]Region 4 covers Montana, Wyoming, North and South Dakota, eastern Colorado, and western Nebraska.

with an accelerated development program. "Accelerated" development would have had its principal impact on 1985 production, resulting in a forecast production of 297,000 bbls/day instead of 293,000 bbls/day under "business as usual" assumptions.

TABLE 5-4

Unconstrained Regional Production Possibilities for Crude Oil, Natural Gas Liquids, Heavy Crudes, and Tar Sands, Region 4 (MT, WY, ND, SD, eastern CO, western NB) (000 bbl/day)

	Business as usual			Accelerated		
	1980	1985	1988	1980	1985	1988
$4/bbl	400	293	235	400	297	236
$7	400	293	235	509	371	284
$11	556	591	607	558	613	635

Source: Project Independence, Task Force Report, November, 1974.

At the time it was prepared, the project Independence Report forecast that a price increase to $11 per bbl without any regulatory changes would increase production to 556,000 bbls/day by 1980, and production would continue to increase rather than decline through 1988, the last year for the projections. Accelerated development would have very little impact in the near future but would considerably increase production in 1988, from 607,000 bbls/day to 635,000.

The situations examined in the Project Independence report illustrate some of the problems in forecasting energy production: prices are already well above $11 per barrel, even adjusted for inflation, while the regulatory and tax environment cannot reasonably be described as either the 1974 "business as usual" or the "accelerated development" scenarios presented in the table.

Nonetheless, petroleum production in both the Old West Region and the U.S. as a whole has increased with the higher prices. However, divergent opinions exist regarding future prices and production rates. In Wyoming, the major crude producer in the Old West Region, the state has projected steady production rates through the year 2000 "assuming that exploration in the state is not restricted " (Wyoming Department of Economic Planning and Development, 1979). This can be further contrasted with the U.S. Commerce Department's "preliminary forecasts" presented in Table 5-5, which show declining production through the end of the century for all the Old West states.

TABLE 5-5

Preliminary Forecasts of Crude Petroleum Production
in Old West States and the U.S.
1985 and 2000
(000 bbls/day)

	U.S.	MT	NB	ND	SD	WY
1985	10,072	85	14	58	.8	350
2000	7,241	60	10	35	-	250

Source: Preliminary Forecast of Likely Energy Production/Consumption Balances for 1985 and 2000 by States, U.S. Dept. of Commerce, Office of Ocean, Resource and Scientific Policy Coordination, 1 November 1978.

5.1.3.2 Natural Gas

Forecasting production of natural gas involves all the technological and policy uncertainties involved in forecasting petroleum production Table 5-6 presents the "preliminary forecasts" of natural gas production in the Old West states and in the U.S. In all cases there is a continued decline through the end of the century (and presumably beyond). However, the state of Wyoming has predicted that "assuming no restrictions on exploration" production from known reserves will remain stable at 300 mmcf through the year 2000 "and new discoveries could triple Wyoming's annual natural gas production during the same span" (Wyoming Department of Planning and Economic Development, 1979).

Of course, whether or not exploration is unrestricted, and whether or not reserves discovered can be exploited are questions of price and national policy. In the recent past, federal policy reversals regarding the use of natural gas as a boiler fuel have made it even more difficult to project with confidence the demand for this fuel.

Production could be further increased through the development of enhanced recovery procedures. Currently only about 32 percent of the oil in place is extractable. The development of techniques to increase the percent extracted even slightly would have the effect of a sizeable addition to reserves. Since reserves are only that portion

TABLE 5-6

Preliminary Forecast of Natural Gas Production
in Old West States and the U.S.
1985 and 2000
(billion/cubic feet)

	U.S.	MT	NB	ND	SD	WY
1985	17,460	40	-	20	-	300
2000	13,000	35	-	15	-	200

Source: Preliminary Forecast of Likely Energy Production/Consumption Balances for 1985 and 2000 by States, U.S. Dept. of Commerce, Office of Ocean, Resource and Scientific Policy Coordination, 1 November 1978.

of oil which is extractable at current prices with current technology, new techniques would increase reserves. For example, an increase from 32 to 35 percent would increase the original known reserves by 10 percent.

Two recent studies completed for the Bureau of Mines have indicated that "mining' procedures could be used to increase the recoverable portion of oil in a reservoir to 95 percent (Energy Development Consultants, Inc., 1978; Edey, Kennedy, Ready, 1978). This would increase United States reserves by 285 billion barrels, with a sizeable portion in the Old West Region. The development and adoption of these extraction techniques would, of course, greatly increase production in almost all producing regions; but depends upon the economic feasibility of their use. Current oil prices are approaching levels at which the use of enhanced recovery procedures may become feasible.

5.2 Uranium

5.2.1 Historical Development

The uranium industry as a whole is a relatively new industry compared to other mineral fuels, and the nonmilitary portion of the industry is of even more recent origin. Within the Old West Region, Wyoming contains the only industrially significant reserves of uranium ore (37 percent of the nation's reserves extractable at $30 per pound of U_3O_8) (U.S. ERDA, 1977) and, as a result, the only significant production.

The bulk of uranium reserves was discovered during two periods of aggressive exploration: one in the middle 1950s and another in the late 1960s. Uranium production did not increase nearly as rapidly as reserves owing to the very rapid rates of discovery and the limited market for uranium.

Table 5-7 presents production data for Wyoming and the U.S. for the years 1967-77. During this period, the only other Old West production occurred in South Dakota; it was sporadic and quite small. As can be seen from the figures in the table, Wyoming's share of U.S. production was increasing during the late 1960s.

TABLE 5-7

Wyoming and U.S. U_3O_8 Production

1967-77

(tons)

Year	Wyoming	U.S.	Wyoming Share U.S. Production (%)
1967	2,667	11,253	23.7
1968	2,873	12,368	23.2
1969	3,063	11,609	26.4
1970	3,654	12,905	28.3
1971	3,487	12,273	28.4
1972	4,216	12,900	32.7
1973	5,159	13,235	38.9
1974	3,767	11,528	32.7
1975	3,447	11,600	29.7
1976	4,046	12,747	31.7
1977	4,990	14,940	33.4

Source: Wyoming's Uranium Industry, Quality Development Associates, Inc., September 1978.

5.2.2 Renewed Demand in the 1970s

Since 1970, the spot price for U_3O_8 has risen from approximately $7 per lb. to over $40 per lb. Recent long-term delivery contract prices have followed the spot market trends, rising rapidly since 1970. The 1977 average domestic price was $19.75 per pound of U_3O_8 (Wyoming Department of Economic Planning and Development, 1978; Boyle, 1977). While energy users would be expected to substitute other fuels for suddenly more expensive petroleum, the rapidity of this change in the spot price for uranium, in the absence of an increase in nuclear power plants, surprised many observers. The difficulty of substituting other fuels for uranium in the short- and medium-term is a partial explanation.

This very rapid rise in price could be explained by the near-simultaneous increase in the price of energy resources generally (following the OPEC actions), and a general reassessment of the extent of undiscovered uranium reserves (Lieberman, 1976).

Whether, in fact, the behavior of uranium prices was the result of such competitive market behavior or collusion on the part of sellers has been raised as a legal question and is currently in court(Wall Street Journal, 1979). Neither the substantive findings of the court nor the findings' significance can be predicted since suppliers (located outside the U.S.) representing a major portion of world production have not responded to legal requests for information and deny the jurisdiction of U.S. courts over their practices.

Rapid price increases accounted for a temporary decrease in Wyoming's production of yellowcake, U_3O_8, in 1974 and 1975. Essentially, the mining firms had been high-grading in extracting and milling the ore. With rapid price increases, it became economical to mill lower grade ore. Since milling capacity was fixed, in the short run, the processing of lower grade ore resulted in the production of smaller tonnages of U_3O_8 in 1974 and 1975. By 1976, new mines and mills had

been opened in response to the higher prices. It has thereafter been possible for greater volumes of ore to be extracted and milled each year with consequent increases in the yellowcake output.

With current high prices, Wyoming's Mineral Division confidently anticipates continued expansion of the state's uranium production (Wyoming Department of Economic Planning and Development, 1979). This anticipation is consistent with the U.S. Department of Commerce projections of 8,000 and 22,000 tons per year of U_3O_8 by the year 2000 for Wyoming and the U.S., respectively (U.S. Department of Commerce 1978). Commerce also anticipates production of 1,500 tons per year. In South Dakota,the only other Old West state for which uranium production is anticipated in this century, the Department of Commerce forecasts production of 1,500 tons by the year 2000.

5.2.3 Future Demand for Old West Uranium Resources

Industry projections of the demand for uranium by electrical utilities are optimistic in the extreme. These projections, if fulfilled, would have all the current $30 per lb. reserves exhausted with thirty years (Lieberman, 1976). The construction of nuclear power plants, however, is so politically volatile an issue, in the U.S. as well as abroad, that these projections must be viewed with some skepticism. Indeed, the Electric Power Research Institute in presenting a range of projections for U.S. uranium requirements stated that "the future of nuclear power is clouded by many uncertainties" (EPRI, 1977). The requirements vary with the degree of growth in nuclear generating capacity, the degree of refining of the raw ore, and the presence or absence of recycling of uranium and/or of plutonium.

Table 5-8 presents the two extremes of these projections: 1) low nuclear growth, (uranium and plutonium recycled) and 2) high nuclear growth (no recycling). These figures should be compared to a total U.S. production of U_3O_8 in 1977 of approximately 15,000 tons and Wyoming production of 5,000 tons (see Table 5-7). One might expect that,

should even this low projection materialize, smaller deposits of uranium in South Dakota, Montana, and North Dakota would be developed. However,

> there is no assurance that federal and state policies will be such as to allow the construction of (this) nuclear capacity.... It is perhaps at least as likely that there will be shortages of generating capactiy as it is likely that the high projection will be achieved. (EPRI, 1977.)

That is to say, the growing public concern over the safety and economy of nuclear power may prevent construction of the number of new nuclear power stations upon whose fuel demands even the low projections are predicated.

TABLE 5-8

U.S. Uranium Requirements; Low and High Cases[a]
(thousand tons of U_3O_8)

	LOW		HIGH	
	Annual	Cumulative	Annual	Cumulative
1980	17	60	25	83
1985	24	121	42	264
1990	28	304	66	541
1995	32	456	96	958
2000	31	614	118	1,501

[a]See text for full explanation.

Source: Electric Power Research Institute, Supply 77, May 1978.

5.3 Coal

5.3.1 Historical Development

As a source of energy in the United States, coal was in relative decline since World War I and in absolute decline since 1947, when production peaked at 630 million tons. The post WW II decline was largely due to the substitution of cheaper petroleum products and natural gas for coal in railroads, space heating and some industrial processes. While the post-war demand for coal was dropping off, surface mining was beginning to be responsible for an increasing share of coal production. In 1947, it accounted for approximately 139 million tons (30 percent) of the national total and by 1977 had increased to 422 million tons, or 61 percent of total coal production. Obviously, the increased role of surface-mined coal during a period of overall decline means that coal production from underground mines dropped significantly.

The coal industry in the Old West Region generally parallelled the national experience until the late sixties. Most of the Old West production was used locally for heating or railroad fuel. Until the present decade, coal production in Montana, Wyoming, and North Dakota did not contribute significantly to national production (less than 3 percent of the total through 1970). Table 5-9 presents production figures for the United States and the Old West states for selected years.

5.3.2 Renewed Demand in the 1970s

The oil embargo of 1973 encouraged the substitution of coal generally, and especially low-sulfur coal, for petroleum-derived fuels. The disruption in international energy markets also extended to natural gas, resulting in utilities and other industrial consumers being encouraged to substitute coal for natural gas. Table 5-9 shows that national coal production had climbed to 691 million tons by 1977 -- increase of 15 percent over 1970 -- with somewhat of a decline (to 654 million tons) estimated in 1978.

TABLE 5-9

Coal Production in the Old West Region and in the United States (thousands of tons)

	U.S.	MT	NB	ND	SD	WY	OLD WEST TOTAL
1940	460,771	2,867	-	2,218	-	5,808	10,893
1950	516,311	2,520	-	3,261	-	6,348	12,129
1960	415,512	313	-	2,525	-	2,024	4,862
1970	602,932	3,447	-	5,639	-	7,222	16,308
1971	552,192	7,064	-	6,075	-	8,052	21,191
1972	595,385	8,221	-	6,632	-	10,928	25,781
1973	591,738	10,725	-	6,906	-	14,886	32,517
1974	603,406	14,106	-	7,463	-	20,703	42,272
1975	648,438	22,054	-	8,515	-	23,804	54,373
1976	678,685	26,231	-	11,102	-	36,836	74,169
1977	691,344	27,226	-	12,028	-	46,028	85,282
1978[a]	653,800	26,680	-	14,625	-	58,175	99,480

[a]Preliminary

Source: U.S. Bureau of Mines, Minerals Yearbook, various years from 1960 through 1975; "Coal-Bitumous and Lignite in 1976," Energy Data Report, Energy Information Administration, U.S. Department of Energy, Dec. 18, 1978; "Weekly Report on Bitumous Coal and Lignite," April 30, 1978 and March 30, 1979, Energy Data Report, Energy Information Administration, U.S. Department of Energy.

The growth in coal production during this decade has been largely achieved through the expansion of surface mining activity in the states west of the Mississippi. In particular, from a 2.7 percent share of national coal production in 1970, the Old West states' production expanded to an estimated 15 percent share (99.48 million tons) in 1978. Of 1978 Old West production, Montana accounted for 26.7 million tons or 27 percent, North Dakota for 14.6 million tons or 15 percent, and Wyoming for the remaining 58.2 million tons or 58 percent. Compared to other states' coal production, in 1978 Wyoming ranked fourth (behind Kentucky, West Virginia and Pennsylvania), Montana ranked eighth, and North Dakota ranked twelfth.

The renewed demand for the coal resources of the Old West Region predated the 1973 Arab oil embargo. Environmental regulations were an important initial factor stimulating the substitution of low-sulfur Old West coal for high-sulfur coal from other regions. This substitution has been made principally by southern and midwestern utilities, due to transport economics and contraints. At present, Montana ships the major portion of its coal out-of-state to markets primarily in Illinois, Minnesota, Michigan, and Wisconsin. A little over two-thirds of Wyoming's coal is exported, primarily to Colorado, Texas, Oklahoma, Missouri, Iowa, Illinois, Indiana, and Ohio. Almost all North Dakota coal production is converted to electricity in-state, while much of the electricity is exported.

The interest shown in western coal is primarily due to its low sulfur content and relative accessibility. The coal in the Old West states reflects these general characteristics; it is typically low-sulfur, low Btu coal, occurring in thick seams relatively near the surface prairie grassland. However, there is considerable variation in Btu content. Lignite, mined mainly in North Dakota, typically produces slightly more than 6,000 Btu/lb. While the subbituminous coals of Montana, and northeastern Wyoming produce about 8,000 Btu/lb. and the coal of southwestern Wyoming produces over 10,000 Btu/lb. (Mountain West

Research, Inc., 1979b). In comparison, eastern coals yield upwards of 12,000 Btu/lb. (Ibid.). The competitive advantage of Old West coal over other coals depends on low extraction costs as well as on lesser pollution control expenditures in its use owing to the low sulfur content.

In the face of massive coal development pressures, the Old West states with coal reserves (Montana, North Dakota, and Wyoming) instituted coal facility siting regulations while revising severance taxes and mining reclamation laws. At the end of this same period, a project natural gas shortage became a surplus and firms that had converted to coal from natural gas were encouraged, in some cases, to switch back. The uncertainties generated by these events, coupled with the long lead times necessary for coal extraction and the near capacity utilization of coal transport facilities, make a clear explanation of annual changes in production and planned mine openings exceedingly difficult.

The excess capacity in coal mines in Montana and Wyoming which has developed in the last two years illustrates the difficulty in forecasting demand for Old West coal. This excess capacity is best explained by the failure of projected increases in electricity use to fully materialize and delays in power plant siting. The former is the result of users' conservation efforts, while the latter is due to a variety of factors, including the regulatory environment and related litigation. In addition, coal transportation bottlenecks and rapidly rising transport costs have also adversely affected coal production in the region.

5.3.3 Future Demand for Old West Coal Resources

The future demand for Old West coal resources is highly uncertain. On the one hand, environmental regulations -- in particular, the limits imposed on sulfur dioxide emissions -- and the stated national policy of

energy independence militate for greater reliance on western surface-mined coal. On the other hand, public and state environmental concerns, federal strip mine reclamation regulations and skyrocketing transport costs have slowed the pace of western coal-energy development and clouded the outlook for significant production increases, at least in the mid-term. The uncertainties inherent in coal resource development forecasts are underscored by conditions of over-capacity in the national coal industry. According to industry estimates, there is currently about 100 million tons of excess production capacity (Wall Street Journal, 25 September 1979). Moreover, the problem is not restricted to small, high cost producers of high-sulfur coal. Excess capacity exists in both Montana and Wyoming mines. According to one Montana producer, the condition may persist "until at least the mid-1980s" (Billings Gazette, 1979b).

5.3.3.1 Forecasting the Price of Coal

Before proceeding with a discussion of the various forecasts of future production in the Old West Region, one must appreciate the role of market price as a key determinant of coal supply. Earler in this chapter, production scenarios for other mineral fuels were seen to be strongly influenced by expected price levels. The discussion that follows, while directed at the problems of forecasting coal prices, applies equally well to other mineral fuels.

The price at which coal will sell in the future is an extremely important variable in any forecasting exercise. Price impacts heavily on the quantity of coal that is demanded in the marketplace. Forecasts that do not explicity include price as an input to the production forecast are, in effect, implicitly assuming one of two different states of the world: (1) the demand for coal is perfectly inelastic, or (2) the relative price of coal does not change. In the first instance, price can be ignored because factors other than price will determine the quantity of coal demanded. In the second, price increases for coal are

assumed to exactly match increases in the general price level (such as the Consumer Price Index). If this assumption holds, any changes in consumption would result from influences other than price effects.

In addition to wanting to forecast price in order to better project increased (or decreased) demand, state governments would like such forecasts so that they can better forecast state revenues. Value-based severance taxes are, of course, determined by the price of the mineral and forecasts of such revenues depend critically on price forecasts.

Despite the desire for and critical nature of price forecasts, little attention has been given to this subject,and the work that has been done has a poor track record in terms of accuracy. The primary reason is that the forecasts depend critically on many factors that are too volatile to predict. As a result, the existing forecasts are significantly off the mark. As we saw earlier (Section 5.1.3.1), Project Independence used $11/bbl oil as the "high" price basis for the 1980 forecasts it made in 1974. This forecast was exceeded by 1977, and the present spot price for oil is above $20/bbl, double the Project Independence high forecast for 1980. This increase was due to a number of unforeseeable events, including the revolution in Iran. The other mineral fuels markets are subject to these same types of unpredictable disturbances. The price of natural gas will depend on the world petroleum market and on the speed of deregulation, an unpredictable political event. The price of uranium will depend in large part on political decisions concerning the construction of nuclear generating plants. The price of western coal will depend on environmental controls, the availability of other mineral fuels, and transport costs.

In short, as a result of the highly charged political factors that affect these markets, together with the simultaneous nature of the markets, it is next to impossible to forecast price with any confidence. This contributes to the high degree of error that surrounds the forecasts of future production levels.

5.3.3.2 Coal Production Forecasts

In 1979, Old West coal production will total about 100 million tons. What levels do industry experts predict will be reached by 1985 and 1990? The most recent set of U.S. Government energy forecasts are those released by the Department of Energy in April 1979 (U.S. DOE, 1979). Table 5-10 presents the DOE forecasts relevant to coal production for 1985 and 1990 under low, medium, and high development scenarios. Note that even under the low scenario, OWR production is forecasted to be double present levels by 1985 and quadruple present levels by 1990. These forecasts are clearly at odds with the current reality of overcapacity and industry's apparent expectation that it will persist through the mid-1980s. One is inclined to be highly skeptical of the DOE forecasts.

Table 5-11 summarizes the results of several earlier coal production forecasts ranging from Argonne National Laboratories' 118 million tons (excluding possible synthetic fuel demands) to Harza Engineers' 163 million tons, a difference of nearly 40 percent. Forecasts for the year 2000 range from Argonne's 220 million tons to EPRI's 1,000 million tons.

Forecasts of coal shipments from the region are illustrative of DOE's assessments of future markets. Figures 5-1 to 5-3 show the projected coal flows for 1981 and 1986. Note that these figures, published eighteen months ago, imply a total OWR production of 173 million tons. in 1986 of which about 20 percent would be consumed within the region. The total production forecast is 26 million tons below the most recent "low" DOE forecast for 1985, reported in Table 5-10. The three figures show the considerable overlap of regional coal markets. For example, Old West coal competes with local and Appalachian coal in the Upper Midwest. By 1986, OWR coal is forecast to compete with midwestern and Appalachian coal in the Mississippi market.

Overall, the future outlook for further development and production of Old West coal resources is highly confused. Price relationships are changing rapidly and major components of delivered coal costs are inflating wildly. For example, a major Montana coal producer reported

TABLE 5-10

Department of Energy Projections of
Coal Production in Old West Region States
(million tons/year)

Producing Area	1985			1990		
	Low	Medium	High	Low	Medium	High
US	974.3	1032.6	1087.8	1286.7	1464.6	1577.8
MT	61.5	77.9	94.4	196.7	280.8	311.4
ND	20.0	26.7	26.7	31.1	31.1	31.1
SD	.4	.5	.5	.6	.7	.6
WY	117.3	119.4	123.5	179.4	223.0	240.1
TOTAL OWR	199.2	224.5	245.1	407.8	535.6	583.2

Source: U.S. DOE Interim Updates to 1985 and 1990 Regional Forecasts, April, 1979.

TABLE 5-11

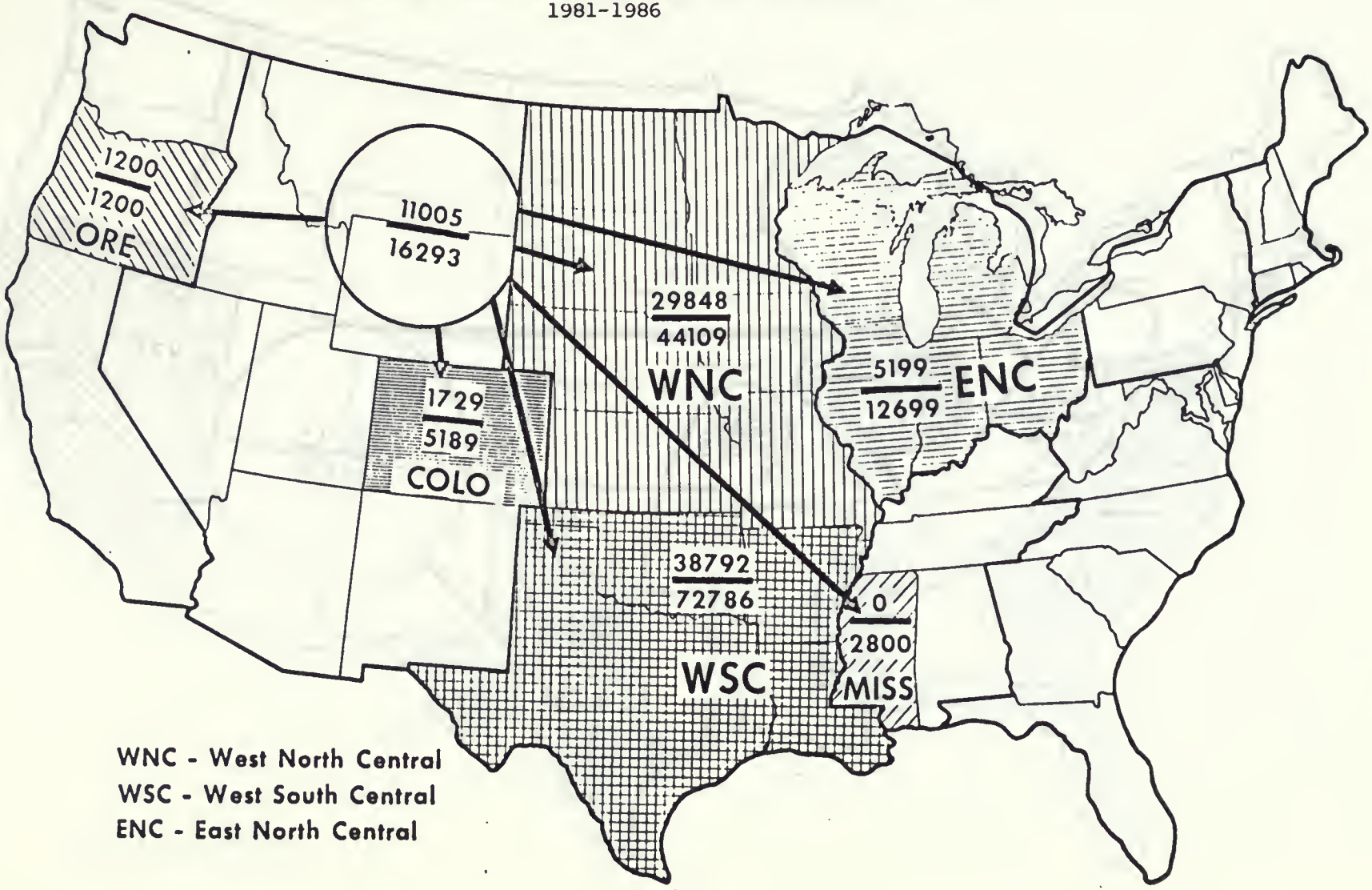
Coal Production for Northern Great Plains Region
(Montana, North Dakota, Wyoming
(million tons/yr)

Forecast	1975	1980	1985	2000	2020	Notes
Argonne	43	NA	118	220	485	Source of steam coal for electric utilities - not for coking or synthetic fuels
EPRI Supply 77	54.4	NA	270	1000	NA	Base case (low sulfur coal)
Harza	NA	NA	162.82	513.10	NA	Most probable case
Northern Great Plains	NA	101.6	155.1	NA	NA	"Business as usual" projection
Yellowstone Basin	NA	NA	162.8	513.1	NA	Same as Harza
Stanford Research Inst.	NA	NA	5.352	16.3	51.1	QUAD Btu figures not in million tons

Source: ABT Associates, Coal/Energy Forecasts: A Nontechnical Evaluation, prepared for Missouri River Basin Commission, Western Coal Planning Assistance Project, August 18, 1978 (Draft Report).

FIGURE 5-1

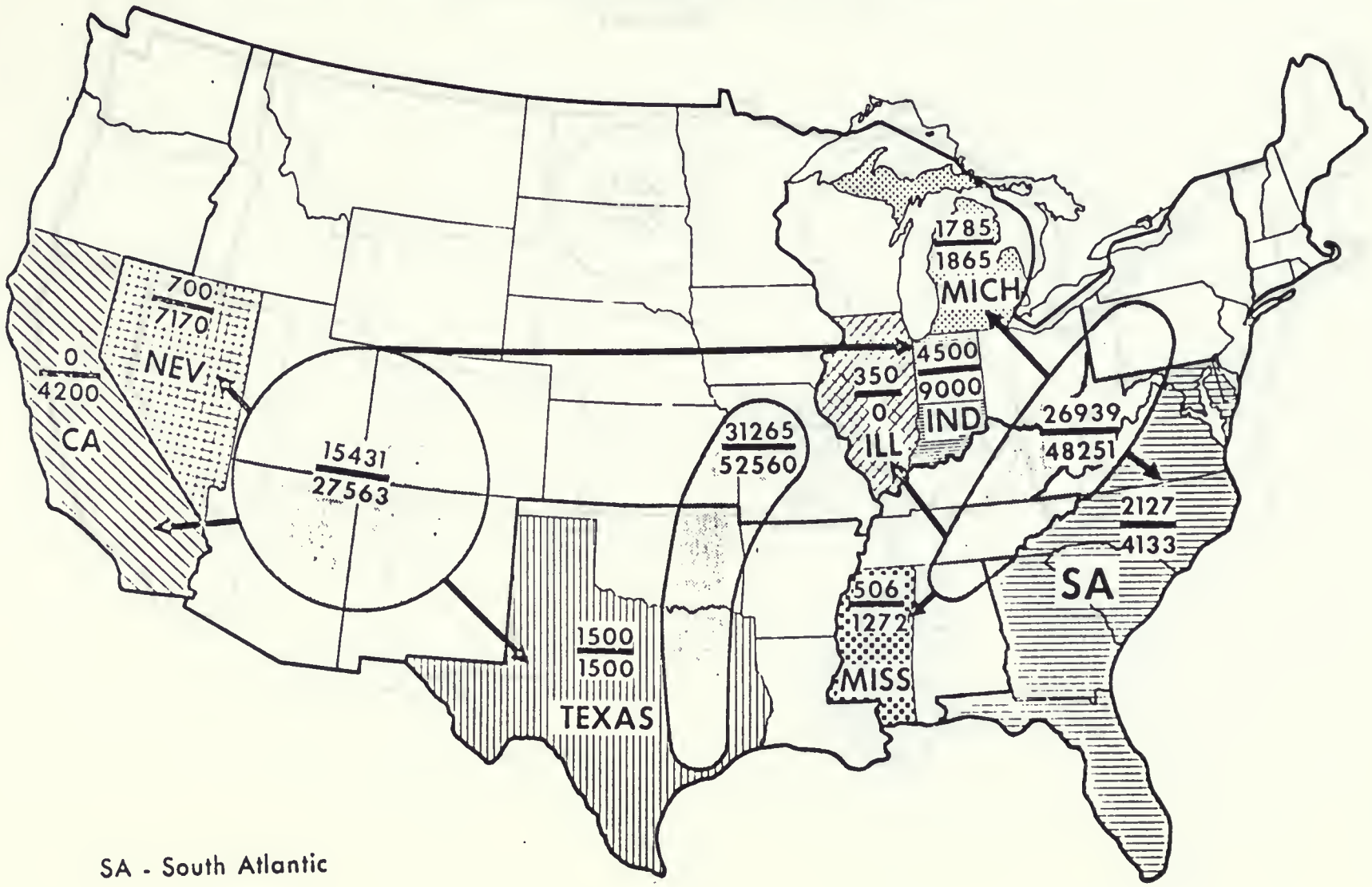
Flow of Coal to New Generating Units from the Western Regions of the Northern Great Plains (in 1,000 Tons)[a] 1981-1986



[a]The numbers in the circles are the quantities of coal consumed with the producing regions. (Source: Status of Coal Supply Contracts for New Electric Generating Units, 1977-1986; First Annual Supplement. Washington, D.C.: U.S. Dept. of Energy, 1978 May.)

FIGURE 5-2

Flow of Coal to New Generating Units from the Appalachian Region, from U.S. Bureau of Mines District 15, and from the Mountain Region (in 1,000 Tons)[a] 1981-1986

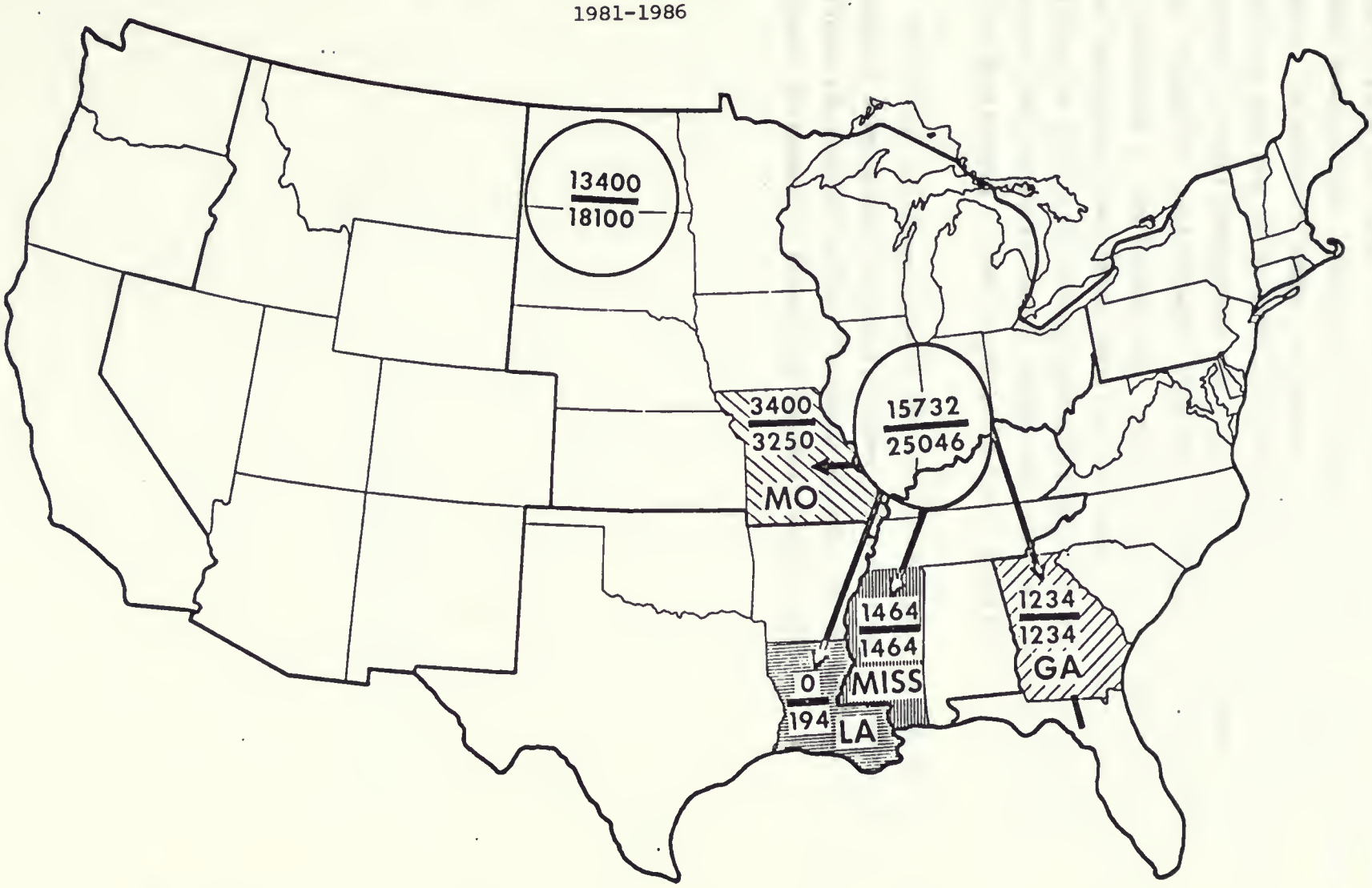


[a]The numbers in the circles are the quantities of coal consumed with the producing regions. (Source: Status of Coal Supply Contracts for New Electric Generating Units, 1977-1986; First Annual Supplement. Washington, D.C.: U.S. Dept. of Energy, 1978 May.)

FIGURE 5-3

Flow of Coal to New Generating Units from the Eastern Region (Interior Province) and the Fort Union Region (in 1,000 Tons)[a]

1981-1986



[a]The numbers in the circles are the quantities of coal consumed with the producing regions. (Source: Status of Coal Supply Contracts for New Electric Generating Units, 1977-1986; First Annual Supplement. Washington, D.C.: U.S. Dept. of Energy, 1978 May.)

transport rate increases of 30 to 35 percent over the last year to Upper Midwest destinations. The prices of competing fuels are also escalating rapidly. In addition, major influences on market price and supply conditions continue to be political and in flux. A radical acceleration of synthetic fuels development has been proposed by the federal government. Meanwhile, environmental regulations continue to offset some of the advantages of low sulfur coal. National policy is inconsistent. It is not surprising that these uncertainties make it difficult for electric utilities to plan additions to generating capacity and thus for mine owners to secure the long-term supply contracts that are prerequisites for the development of additional production capacity.

The historical experience of OWR coal production, in contrast to optimistic development forecasts, argues for conservative projections of future production levels. Certainly current market conditions render any major increases in production unlikely before 1985.

6. IMPACTS, INCIDENCES, AND INTERSTATE SHIFTING OF DIFFERENT MINERAL FUELS TAXES

6. IMPACTS, INCIDENCES, AND INTERSTATE SHIFTING OF DIFFERENT MINERAL FUELS TAXES

This chapter examines the question of incidence of various taxes on mineral fuels, the question of under what conditions taxes might be shifted to consumers of those fuels, and the question of how mineral fuels interstate tax shifting compares with the exportation of other types of taxes by states. The first section (6.1) addresses the concept of incidence and defines the key economic terms important to its understanding. It then discusses the implications of different market conditions for mineral fuels tax incidence, by type of tax. Section 6.2 takes up the case of interstate tax shifting (tax exporting) with respect to coal. Particular emphasis is placed on the shifting of coal severance taxes. In Section 6.3, the discussion of interstate tax shifting is expanded to the national level. Here the exporting of different taxes is examined, comparing performance of the Old West states with that of other states -- particularly, Michigan, California, Florida, Illinois, Wisconsin, and Nevada. The discussion reveals just how pervasive the interstate tax shifting phenomenon is and the increasing degree of tax exporting in all states since the early sixties.

6.1 Incidence Theory and Mineral Fuels Taxes

6.1.1 Statutory Incidence and Economic Incidence

The statutory incidence of a tax is of primary importance to government officials who must collect, and to firms who must pay, these taxes. Once a tax statute has been enacted, a collecting and reporting burden is placed on the firm or individual unit that has the legal liability for the actual payment. This statutory incidence is easy to ascertain, but is of limited interest to the economist. Once a tax is enacted, taxpayers will attempt to transfer the economic burden of that tax to others. The question of who ultimately pays the tax is referred to as "the economic incidence" of the tax.

Two important points must be kept in mind in trying to determine economic incidence. First, the economic incidence can (and usually does) differ significantly from the statutory incidence. Legislators are sometimes aware of this fact when they enact the taxes; often, however, the lawmakers have no idea of the true economic incidence of the taxes they enact. In some cases, the difficulty of determining the economic incidence makes the tax a "good" tax from a legislative point of view, because none of the competing groups knows who is paying the tax. The second point is that all economic incidence ultimately rests on individuals. Taxes may be imposed on business firms, but the economic incidence can be traced to households and individuals in their capacities as either owners of the firm, employees of the firm, or consumers of the product the firm produces or sells.

As a matter of economic interest and policy concern, we must look at the economic incidence after all tax shifting has taken place. In this context, the burden of taxation can be judged. This means that we must examine the economic environment after all participants have adjusted their behavior to the tax. In many cases, this is a very difficult task. Complex problems arise in tracing the way in which market participants react to the tax's impositions. Nevertheless, despite all the difficulties involved, it is only through such exercises that the real economic burden of statutory incidence can be uncovered.

6.1.2 Some Preliminary Concepts

Any discussion of tax incidence demands a careful definition of terminology.

6.1.2.1 Direct vs. Indirect Business Taxes

The distinction between direct and indirect taxes is an ambiguous concept, but economists usually reserve the term "direct taxes" for those taxes where the economic incidence and the statutory incidence are the same. In other words, the legislative body intends to tax a certain group of individuals and places the tax directly on those individuals. "Indirect taxes" are those that are imposed by the political system at a point that is different from their economic incidence. These taxes are meant to be shifted.

6.1.2.2 Tax Burden

Before we try to determine who bears a tax burden, we must define what is meant by a tax burden. The purpose for which taxes are collected is important in this regard. For example, the governmental unit collects taxes to transfer resources to the public sector, such as building an airport. In this case,we must determine how this burden is shared among taxpayers and how the benefits of the airport are shared among these same taxpayers. It is important to note that in this example there are redistribution aspects because those paying taxes and those receiving benefits are not always the same set of citizens. Since this holds for almost all governmental programs, the tax incidence must be compared to the incidence of the benefits. In other words, the net impact must be examined to determine the burden of the resource transfer. When there is no public expenditure on a project that has a benefit incidence, as when the governmental unit taxes a group and redistributes the revenue to another group for consumption in the private sector, the problem of incidence requires only tracing the redistribution that has taken place.

6.1.2.3 Absolute and Differential Incidence

One way to determine incidence is to trace the absolute effects of an increase in a particular tax by holding expenditures constant. However, for the purposes of this analysis this approach is unsatisfactory because the tax increase will have macroeconomic effects on the economy, if there is no offsetting decrease in another tax. Macrodistributional effects cannot be separated from the effects of the tax; any determination of incidence is, therefore, muddled.

In order to avoid these macroeconomic difficulties, tax incidence analysis examines the incidence of a particular tax by assuming that total expenditures remain constant, and that any change in the tax under study is compensated for by offsetting changes in other taxes. The redistribution and/or economic effects that take place can then be assumed to be the result of the tax itself, rather than the result of any macroeconomic changes. In addition, this view of tax incidence conforms to the way taxes are usually set because tax policy decisions usually involve choices among alternative tax mechanisms for raising revenue.

6.1.2.4 Tax Shifting

The incidence of a tax depends on how successful economic units are in adjusting to that tax or in shifting the burden to other units. This shifting process will depend on how the tax is assessed and on its statutory incidence. Tax shifting is also a function of how general the tax's application is (general taxes are more difficult to shift than are specific taxes because they cover "everything" in the market structure in which the firms and the owners of the factors of production operate, including labor, and of the length of time that various markets have had to adjust.

6.1.3 The Incidence of Mineral Fuels Taxes with Different Market Conditions

To determine the degree of tax shifting, it is necessary to examine each tax in the context of the market structure of the industry on which the tax is placed.

6.1.3.1 Property or Ad Valorem Taxation

There are several possibilities to consider in assessing the incidence of a property tax on mineral fuels in a competitive industry. First, if the industry is perfectly competitive with firms earning only a normal rate of return, the property tax will increase costs and will cause returns to be reduced below normal levels. Firms will leave the industry until profit rates reach normal levels again. In this long run scenario, the burden of the property tax will be shifted forward to consumers, who must pay the tax in order to return the industry's profits to normal levels.

A second and more likely scenario in the framework of a competitive mineral fuels industry is that some mine or well sites are more fertile than others. This means that the more fertile ones are earning inframarginal rents. A property tax in this case need not be entirely

shifted forward, because some of the tax will be paid by the recipients of these inframarginal rents.[1] In this case, the burden of the tax falls on both the consumers of the mineral and the initial mine owners. Subsequent owners will pay a lower price for the mine, since the property tax is capitalized in the value of the mine.

Consider yet a third scenario: assume the industry is competitive, but the mines in one jurisdiction are uniformly more rich in ore than are those in another taxing jurisdiction. Since the price is determined by competitive forces, the owners of the richer mines are earning locational rents. Taxing this rent via a property tax will not affect the price at all; instead, it will be paid solely by the owners of these prime sites. In this case, the burden falls solely on the initial owners of these mines because, once enacted, the tax is capitalized into the value of the mine and, in this way, is avoided by future owners. Conversely, if the geographic area in which the property tax is enacted contains the marginally productive mines, a property tax will close these mines. In this case, the tax is again paid by the mine owners. An important point emerges from this scenario: firms selling outside the taxing jurisdiction are not in a very strong position to shift the tax forward to consumers. This simply follows from the availability of other sources of supply in non-taxing jurisdictions. A property tax on a competitive industry selling outside its own taxing jurisdiction can have very harmful effects on that industry, unless some factor, unique to this jurisdiction, contributes to locational rents.

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[1] By inframarginal rents, we mean payments that are not necessary for this firm to produce. Boulding has emphasized that, whenever the supply of factors is not perfectly elastic, a portion of the return consists of rent. Other texts sometimes refer to inframarginal rents as producer's surplus. In Boulding's development, the only firm not earning a rent is the marginal firm. An example in labor markets would be that as wages rise to entice more laborers into a particular field, all those laborers that were in the industry before the rise and all those who would have entered at lower wages are receiving inframarginal rents. Only the marginal unit of labor does not receive rent. See K. E. Boulding, "The Concept of Economic Surplus," American Economic Review (December 1945).

If the firms sell in a monopolistic rather than in a competitive market, the conclusion is that a general tax on capital value falls on the owners of that capital. Introduction of a property tax does not affect the marginal costs of the production unit and, therefore, does not change the optimal price. There is no shifting forward to consumers since the tax is paid out of the monopoly returns.

6.1.3.2 Per-Unit Severance Taxes[1]

Per-unit severance taxes are imposed on sales or products based on a physical measure of those sales or output. The severance tax is a selective tax that is imposed only on mineral fuels and excludes taxation on the production and sales of other goods in the taxing jurisdiction. As a result, we must compare the position of consumers of a mineral fuel and the consumers of the other tax-free goods, before and after imposition of the tax. Since the sale or production of mineral fuels is taxed and since the sale or production of other goods is not taxed, the market price of mineral fuels increases relative to the market price of other goods. Thus, the shifting of the burden depends on how consumers and producers respond to these changes in relative prices.

The response of consumers and producers depends on the elasticities[2] of supply and demand in the relevant markets. In addition, the amount of the tax that each pays depends critically on the supply and demand elasticities for the mineral fuel that is being taxed. Examining the four panels in Figure 6-1, we can easily see how the elasticity of supply and the elasticity of demand affect the tax incidence.

In panel (a) of Figure 6-1, a normally sloped supply curve (S) and a perfectly inelastic demand curve (D) are shown. When the severance

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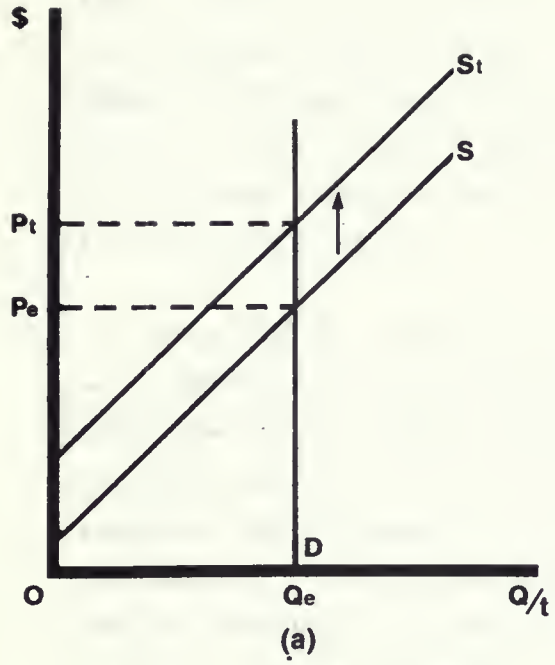
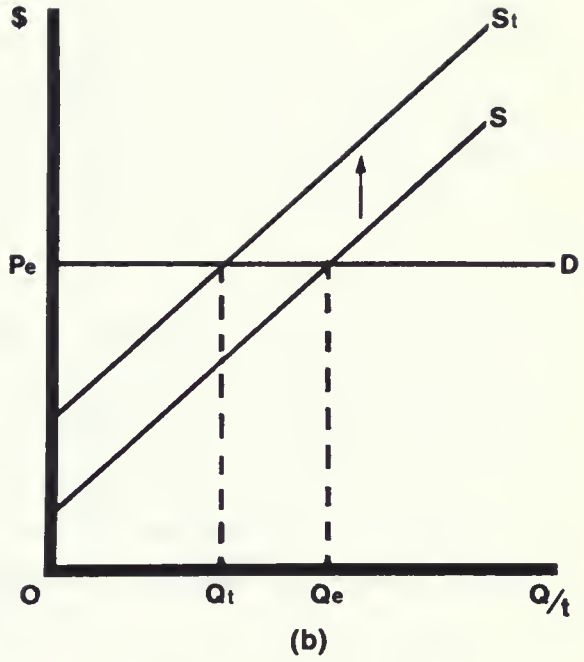
[1] A more detailed discussion of severance tax incidence is presented in Section 6.2 for the case of coal.

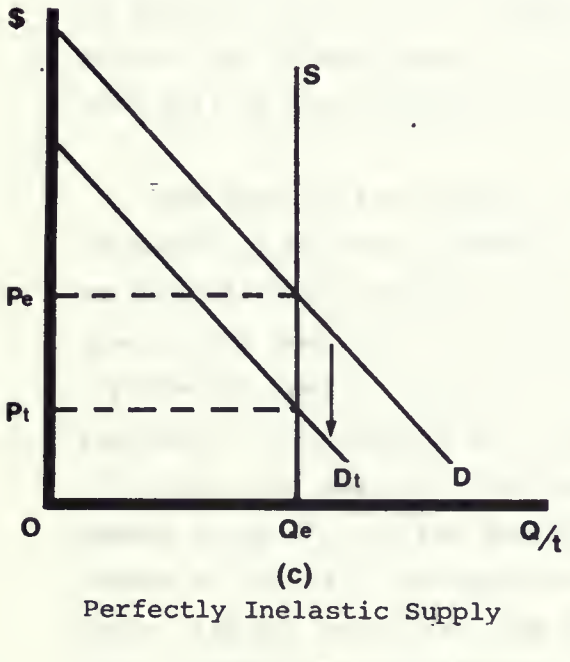
[2] In economics, elasticity relates the percentage change in one variable to the percentage change in another variable. Price elasticity of demand is the ratio of percentage change in quantity demanded to percentage change in price; it is a measure of the responsiveness of desired purchases to changes in price. If this ratio is less than 1.0, the demand is said to be inelastic. If the ratio is equal to one, demand is said to be unit elastic; and if it is greater than one, demand is elastic.



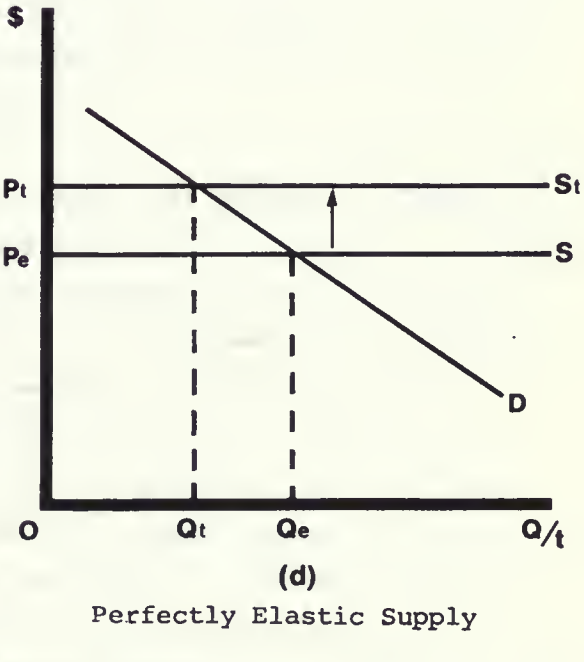
Perfectly Inelastic Demand



Perfectly Elastic Demand



Perfectly Inelastic Supply



Perfectly Elastic Supply

FIGURE 6-1. Elasticity assumptions and tax incidence

tax is placed on the goods, the supply curve shifts to S_t. The result is that price rises from OP_e to OP_t. Price has risen by the full amount of the tax, and the equilibrium quantity has not changed. In this case, the incidence of the excise tax falls fully on the consumers of this good. The tax has been shifted forward to consumers by the full amount of the tax.

Panel (b) of Figure 6-1 illustrates a normally sloped supply curve and a perfectly elastic demand curve. The post-tax supply curve is S_t. After the tax is imposed, price is unchanged at OP_e and equilibrium quantity falls to OQ_t. The incidence of the tax is fully on the suppliers of this good. Since the price to consumers is unchanged, the producer is paying the entire tax, but consumers are receiving a smaller quantity than they were previously.

The principle involved in panel (a) and panel (b) is clear. The more inelastic the demand for a good, the more any severance tax placed on the good will fall on consumers of that good. Conversely, the more elastic the demand curve, the more any excise tax placed on the good will fall on the producers of that good.

Now examine the supply curves in panels (c) and (d) of Figure 6-1. In panel (c) we have a perfectly inelastic supply curve (S). In order to geometrically represent the tax, the demand curve (D) is shifted down by the amount of the tax (to D_t). It is impossible to shift back a perfectly inelastic supply curve, because such a supply curve represents the offering of a fixed amount regardless of price. In this case, the tax cannot affect that given quantity. We view the demand curve (D_t) as the demand curve the industry faces, less the amount of the tax. The equilibrium quantity is unchanged after the shift, and the price the firm receives falls from OP_e to OP_t. In other words, the entire amount of the tax has been paid by the suppliers of the good. In panel (d), we have a perfectly elastic supply curve. A severance tax results in the shifting of the supply curve to represent the higher price at each level of output.

After the shift, the price increases from OP_e to OP_t. In this case, consumers are paying the entire tax. Some producers may be worse off because less is being sold, but consumers end up paying more for OQ_t; this increased amount is exactly equal to the amount of the tax.

This exercise in shifting supply and demand curves develops some general propositions about severance taxation incidence. The more inelastic the demand, the more prices will rise, meaning that proportionally more of the tax will be paid by consumers; the more elastic the demand, the less price will rise, indicating proportionally more of the tax will be paid by producers. The more elastic the supply, the more price will rise, indicating the tax will be paid by consumers; and the more inelastic the supply, the less the price will rise, meaning the tax will be paid by producers. The answer to the question of who pays the severance tax should be clear: it depends. The relative elasticity of supply and demand in the market for the mineral fuels on which the tax is placed, including the availability of close substitutes for the fuels, will determine the incidence.

Of course, the markets for mineral fuels do not have perfectly inelastic supply and demand curves. These principles, however, allow us to determine the likely burden of severance taxation, given realistic assumptions concerning demand and supply. In every real-world market, part of any tax is borne by consumers and part by producers. Consider Figure 6-2, for example, which represents "normally" shaped demand and supply curves. A per-unit severance tax of t per ton shifts the supply curve up by the amount of the tax (to S_t). Market price rises to OP_2 and the quantity falls to OQ_2. In this case, part of the tax is shifted forward (price rises from OP_1 to OP_2), which is not the entire amount of the tax. Some of the tax is paid by producers, who now receive OP_3 for their production rather than OP_1, the original price. Again, the determination of the relative sharing of the burden depends on the relative elasticities of supply and demand.

In the case of monopoly, the effects of a per unit tax are similar but less pronounced than in the case of competition. It can be shown

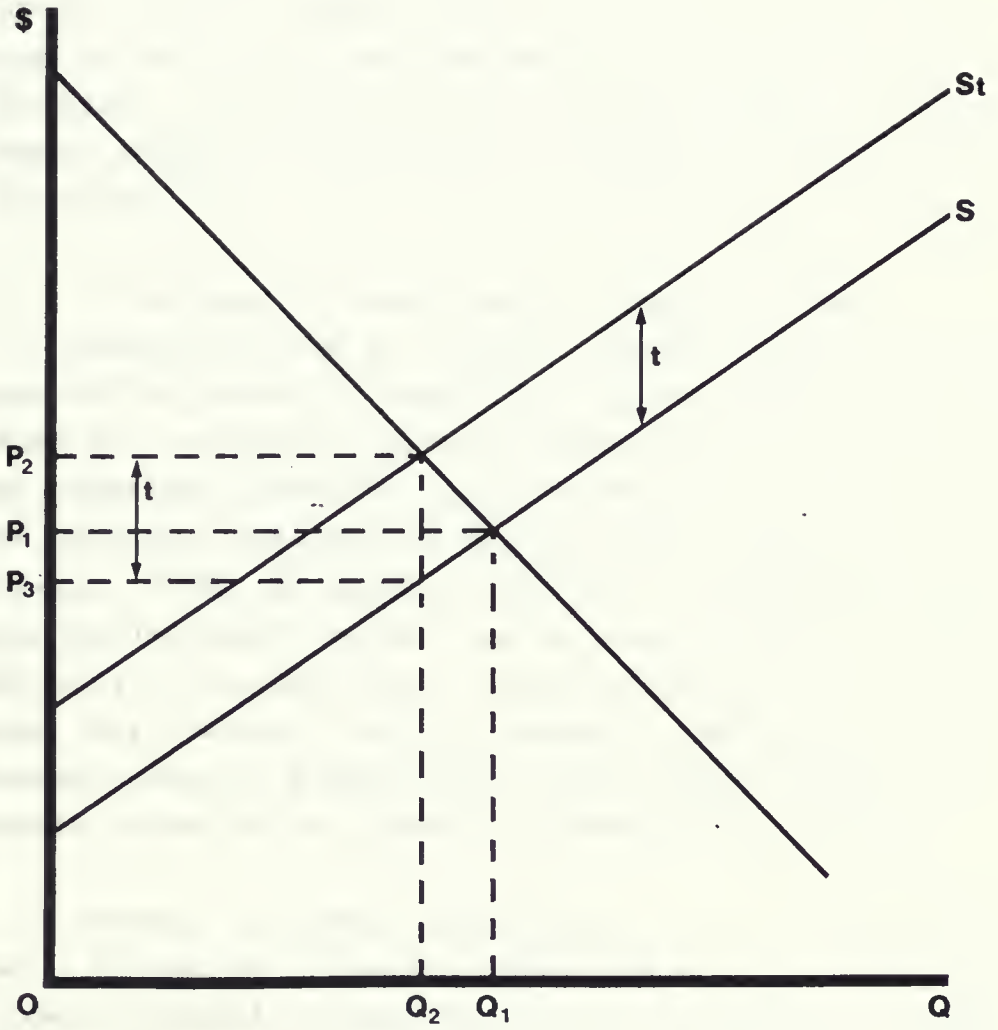


FIGURE 6-2. Shared burden of per-unit severance tax

in the special case of a linear demand curve, with a normal downward slope, and a normal linear supply curve, with a positive slope (as in Figure 6-2), that the increase in monopoly price due to an increase in taxes is one-half the increase in price that occurs in the competitive case. This results from the fact that the per-unit tax reduces the monopolist's marginal revenue by the amount of the tax. In practice, this means that the shifting again depends on the elasticity of demand and supply, but that with a monopoly less of the tax is passed on to consumers than is the case in a competitive market structure.

6.1.3.3 Value-based or Gross-Production Severance Taxes

A severance tax that is imposed on a percent of price or value, rather than on per-unit of output, presents the same general incidence problem, but can enter into price determination in a different way. Under competitive conditions, it can be shown that per-unit and value-based taxes that yield the same revenue have the same effect on price and output. Thus, the incidence effects of value-based and per-unit taxes, yielding equal revenues, are the same. In this case, the value-based tax is preferable because it makes the severance tax on different mineral fuels the same. This is a desirable feature if equity or equal treatment provisions dictate that uniform treatment under the tax structure is desired with regard to different mineral fuels.

In monopoly, the situation is different. It is most simple to view a tax as a reduction in revenues rather than as an increase in costs. As shown in Figure 6-3, imposition of the value-based tax "swivels" the marginal revenue, and average revenue (net of the tax) curves down and to the left. In this case, price rises (from OP_1 to OP_2) and net profits fall. In other words, the tax is partially borne by both producers and consumers of the item. The amount of the shifting will depend on the relative price elasticities of demand and supply for the mineral fuel. As Figure 6-3 demonstrates, the more inelastic the supply (or marginal cost) curve and the more elastic the demand curve, the more heavily the tax will fall on net profits. As before, the more inelastic the demand, the more the tax will increase price, which

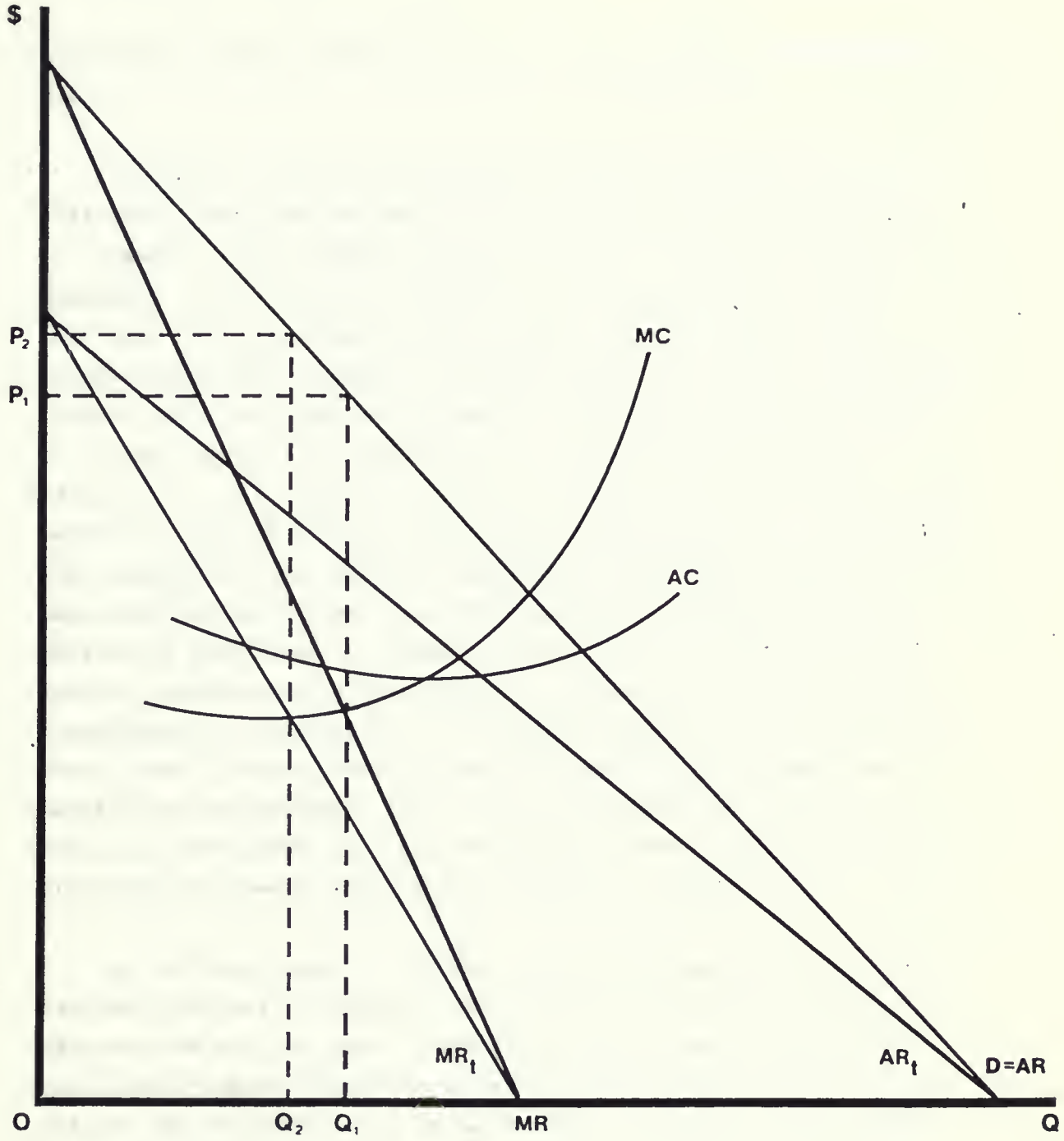


FIGURE 6-3. Value-based severance tax on monopoly

indicates a forward shifting of the tax to consumers of the mineral fuel.

The effect of both a per-unit and a value-based severance tax on efficiency conditions depends on the relative elasticity of supply and demand in the market for a particular good and on the market structure in that particular industry. It is important to keep in mind that efficiency impacts and incidence are separate (though sometimes related) questions. Every tax has an incidence; some taxes, however, have no effect on efficiency. Indeed, some taxes, referred to in the theory of second best, have the effect of increasing efficiency. Selective taxes, such as severance taxes, generally cause markets to diverge from the efficient price and output, if the markets are competitive. In this case, price increases cause consumers to move away from efficient levels of consumption, where efficiency is defined as that level of consumption at the point where the marginal rate of substitution in consumption is equal to the marginal rate of transformation in production. The severance tax, by causing prices to rise, drives a wedge into this equality, by causing prices to be higher than the marginal rate of transformation in production. In this case, the inefficiencies introduced are greater as the price increases are greater (see panels (a) and (d), Figure 6-1).

On the other hand, if the markets are monopolistic or if serious external problems are present, the introduction of the severance tax can move the marginal rate of transformation to the "true" rate and can actually cause the system to become more efficient. This is the role of the severance tax as a second-best instrument, as discussed in Section 2.1.3.

6.1.3.4 Net Production Severance Taxation

As was discussed in Section 3.5.2, the net-production severance tax is not analogous to an excise or severance tax for purposes of examining its incidence. Instead, it is necessary to trace the net production severance tax in much the same manner as one would trace the corporate income tax. This is a very difficult undertaking, as

the incidence of the corporate income tax is the most controversial issue in incidence history. If the tax is imposed on a select industry, and if this industry is competitive, net returns in the industry are reduced, and capital flows out of the industry. As a result, output falls, and the price of the products rises until the rate of return has been restored. The burden of the tax falls on capital in all industries, because the capital that leaves the taxed industry lowers the rate of return in other sectors of the economy in which the capital is subsequently invested. The story does not end here; since less capital now exists in the taxed sector of the economy, labor will be less productive (assuming that capital and labor are complementary).

If the markets are influenced by monopoly power, the analysis is even more complicated, since the incidence of such a tax is a hotly debated theoretical issue. A determination of shifting cannot be based on theory, but must be empirically determined for each industry on which such a tax is placed.

6.2 Mineral Fuels: the Case of Coal

The theoretical discussion of tax shifting can now be combined with evidence regarding the structure of the coal industry and its markets to determine the most likely magnitude and direction of tax shifting. In Section 6.2.1, the possibilities of shifting severance and other taxes in a competitive environment are examined. Section 6.2.2 presents a discussion of effective ownership of coal, which because of standard practices in the coal industry may not be intuitively obvious. The coal industry is examined for relevant characteristics in Section 6.2.3. The significance of those characteristics for tax incidence analysis is also evaluated. Finally, Section 6.2.4 summarizes the findings regarding the probable direction and magnitude of coal tax shifting.

The section focuses on Old West coal resources that are mined and shipped to out-of-state utilities. The differential incidence of coal extracted for mine-mouth conversion or for export is not explicitly examined, since there is no reason to suppose it exists. The demand for coal is seen to be derived from the demand for the final product, and

thus the choice and location of conversion facilities would not affect the incidence findings.

6.2.1 Tax Shifting in an Idealized Model

The standard reference point for economic analysis is a theoretical model known as pure or perfect competition. In its formal elaboration, this model contains many simplifying assumptions,[1] but generally seems to simulate the U.S. economy rather well.[2] In this section, we will first investigate the incidence[3] of severance and property taxes on coal in a competitive environment, examine the market for coal, and then assess the significance of observed conditions in that market for tax incidence.

An important and basic feature of a competitive market is a large number of buyers and sellers, all of whom are well informed. In the case of coal produced in Old West states, the buyers are primarily electric utilities, and the sellers are the owners of the coal reserves. Other parties of interest are, of course, the mining companies (which may, but need not, own reserves) and utility customers. In the case of captive mines, the electric utilities and mine owners are the same.

The demand curve for coal is a derived demand curve; that is, the demand is not by consumers for coal itself, but by business firms (utilities) to produce goods (principally electricity) that consumers want. As such, this demand curve reflects the substitution possibilities of consumers for electricity (natural gas, fuel oil, insulation, more efficient motors in appliances, etc.) and of industrial purchasers for coal (natural gas, fuel oil, more efficient generating plants, etc.).

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[1] Any model, or representation of reality, will be "unrealistic" in the sense that not all characteristics of the event will be represented.

[2] For a more detailed explanation and defense of this model, see any introductory textbook in microeconomics, such as Paul Samuelson's Economics (McGraw-Hill, New York) or M. Spencer's Contemporary Economics (Worth, New York).

[3] A discussion of tax incidence was presented in the preceding section (6.1).

The coal supply curve reflects both payments to mining firms for extracting the coal and payment to coal owners for their rights to the coal. The upward slope of the supply curve is primarily a result of the fact that increased production of any mineral resource requires the exploitation of less accessible deposits. This rather elementary fact accounts for the distinction between resources and reserves: reserves must be both known to exist (with greater or lesser degree of certainty) and be extractable at a cost no greater than the price of the mineral. Figure 6-4 illustrates how reserves are distinguished in the total resource base by both the extent of knowledge regarding their existence and the feasibility of their extraction at current prices with current technology.

The upward slope of the supply curve reflects the common existence of higher extraction costs associated with the more rapid exploitation of a given deposit. However, this is not very important since other deposits exist for which extraction costs are lower and thus will be developed instead. Figure 6-5 depicts this situation, illustrating the effect of different concentrations of deposits on production. Curve A depicts a situation in which price increases make attractive much smaller increases in production (due to rapidly rising extraction costs) than the reference case, Curve C. Curve B illustrates a case where very large increases in the rate of extraction can be achieved with only a slight increase in unit costs.

For individual firms, the analysis is somewhat different than for the market as a whole. The supply curve will slope upward, reflecting increased costs of more rapid extraction from current mines or the costs of acquiring additional reserves. The demand curve faced by an individual firm in a competitive market, though, is horizontal because of the buyers' ability to shift purchases to other firms.

6.2.1.1 Severance Taxes

It is within the above context that a severance tax on coal must be viewed. Of crucial importance is the portion of total output on which the tax is imposed. If the tax is imposed on only a small portion

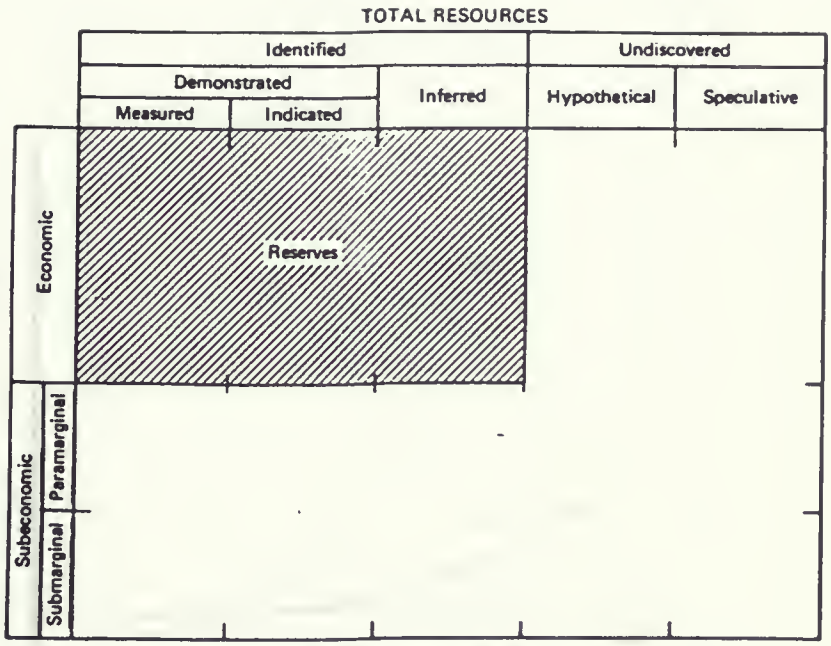

FIGURE 6-4. U.S. Bureau of Mines/U.S. Geological Survey mineral and coal resource and reserve categories. Source: Dept. of Interior news release, "New Mineral and Coal Resource Terminology Adapted." 26 May 1976.

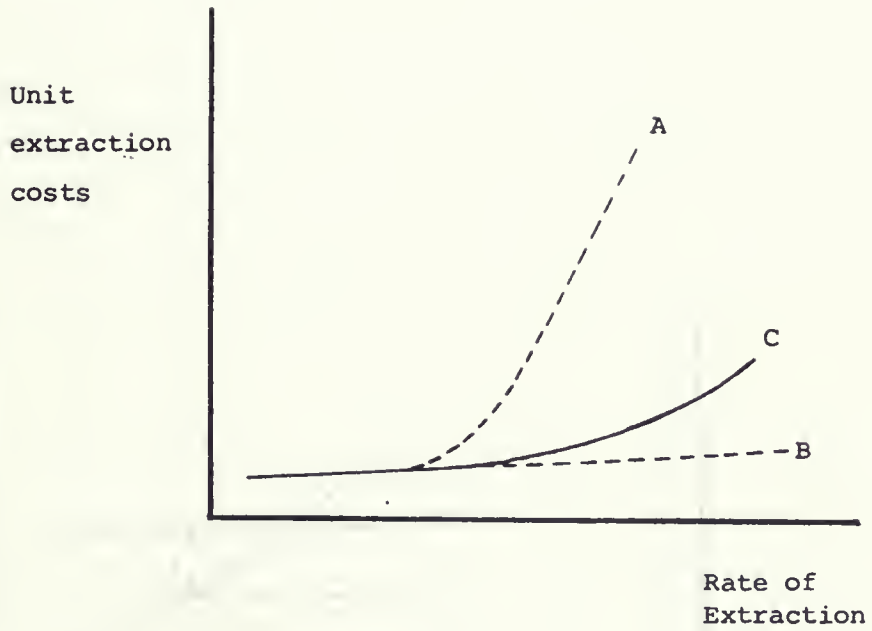

FIGURE 6-5. Relationship of unit extraction costs to production under alternative scenarios

of the total production, the market price will not be affected. In Figure 6-6, the extreme case of only one firm being taxed (or alternatively, the effect on one firm of a tax imposed on a small portion of total production) is illustrated[1]. In panel (a), this tax is interpreted as a downward shift in the demand curve faced by the firm. The shift is the amount of the tax, t. The presence or absence of the tax would not be expected to change purchasers' willingness to buy coal; they will be influenced by the price of the coal and will continue to pay P_1, the market price. The mine will receive only P_2, though: the market price less the tax. At this lower price production will be reduced from Q_1 to Q_2.

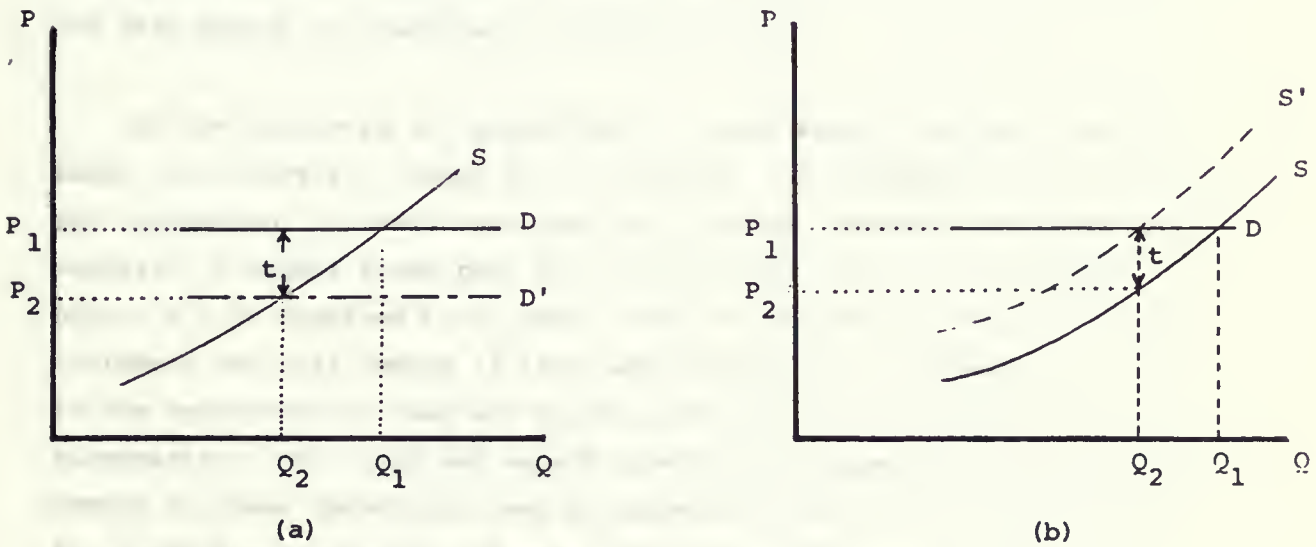

FIGURE 6-6. Effect of highly localized tax on production

[1]Imposition of the tax on a single firm, earning only normal profits, would probably force it to shut down.

An alternative argument is that the tax would be manifested as a producer's insistence to be paid a higher price for the coal because of the tax. This is illustrated in panel (b) of Figure 6-6, with the tax presented as an upward shift of the supply curve. Purchasers' desires would still not be influenced by the tax. They would pay P_1; producers would receive P_2 (the market price less the tax); and, production would decrease to Q_2 from Q_1. It makes no difference for the incidence analysis whether a tax is interpreted as a perceived downward shift in demand or an upward shift in supply. In both cases, the post tax price and the pre-tax price are the same. The tax does not affect price.

Who then pays this tax? Not consumers, certainly, since the coal continues to be purchased at the same price. If labor and capital are to remain in the mining industry, they must receive the same return as in other industries. The rent[1] received by coal owners can be reduced, though, since the alternative to a lower revenue is no extraction and no revenue. Therefore, one may conclude that a highly localized severance tax in a competitive market will be borne by the owners of the mineral. The implications of this conclusion for states in the Old West Region are examined in Section 6.2.4.

If the tax is on all production, no such simple statement can be made. In Figure 6-7, panel (a) illustrates the case where the tax is on all production. In this case,the tax is shared between publishers and sellers: a higher price than P_1 is paid by buyers, P_3; but a lower price, P_2, is received by sellers. The tax must be shifted to utility customers and coal owners if labor and capital are to remain employed in the extraction of coal and in the generation and distribution of electricity. One would not expect investors to accept a lower rate of return in these industries than in competing alternatives, nor workers to accept lower salaries and wages than could be earned in other positions requiring the same skills. This was discussed more fully in Section 6.1.

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[1] See page 90 of this report for a definition and discussion of rent.

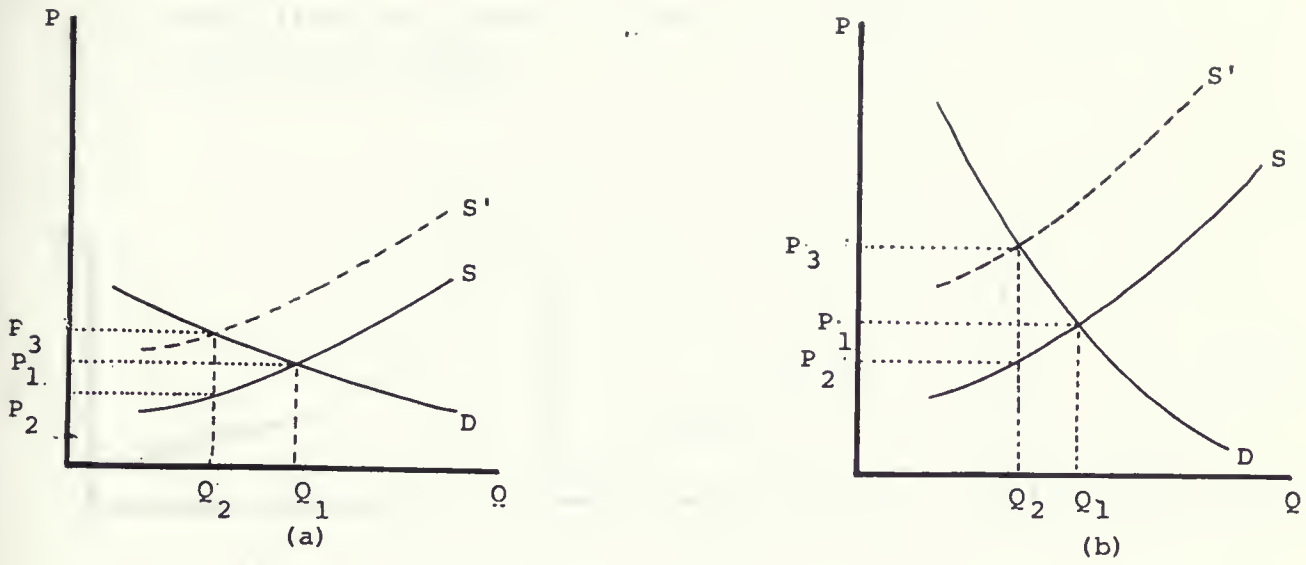

FIGURE 6-7. Effect of universal tax on production

Panel (b) in Figure 6-7 illustrates the importance of quantity responsiveness to price. The demand curve in panel (b) is drawn to be less elastic (i.e., the quantity demanded is less responsive to changes in price) than in panel (a), and a larger portion of the tax is borne by consumers. Generally, the more inelastic the demand, the greater the portion of the tax shifted forward (to purchasers); the more inelastic the supply, the greater the portions shifted backward (to input suppliers). The principles involved here were discussed in detail in Section 6.1.

If the tax were imposed in a jurisdiction that contributed a significant portion, but not all, of total production, the supply curve for the entire industry would be shifted upward; but, the shift would depend on the type of reserves in the jurisdiction. Were there only very accessible reserves, the lower portion of the supply curve would be lifted. If the reserves were of moderate accessibility, the middle portion of the supply curve would bulge upward; only low-grade deposits would bend the upper portion of the supply curve to be more steep. These

possibilities are shown in Figure 6-8; the dashed line represents the post-tax supply curve.

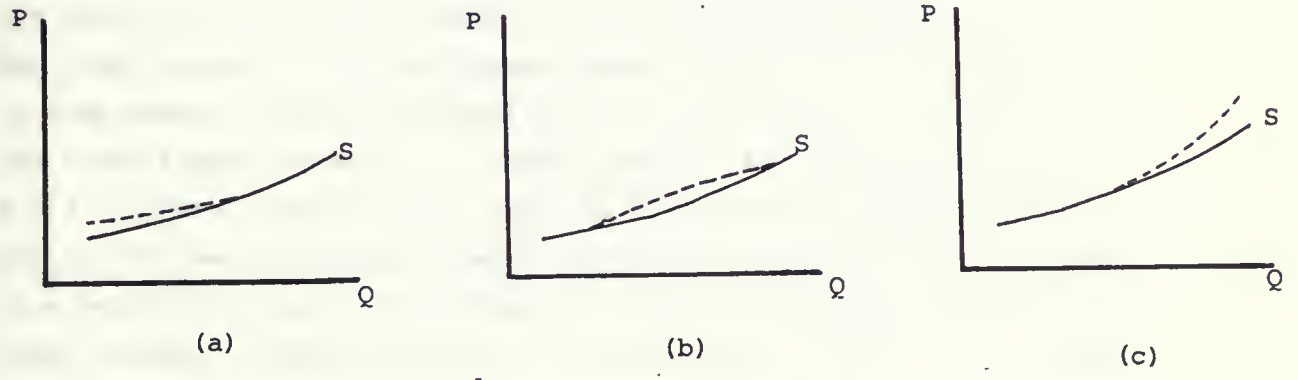

FIGURE 6-8. Supply curve shifts as a function of reserve accessibility and quality in taxing jurisdiction

Of course, the deposits within a single jurisdiction would not usually be of uniform quality and accessibility, causing a rather irregular shift in the supply curve.

To summarize, the extent to which a severance tax is shifted forward to consumers depends importantly on the portion of reserves subject to the tax, the price elasticity of demand, and the price elasticity of supply. The smaller the portion of reserves subject to the tax, the greater the portion borne by resource owners; the more inelastic the demand, the greater the portion of the tax borne by consumers; the more inelastic the supply, the greater the portion of the tax borne by resource owners. Note that these are generally the same results as presented in Section 6.1. The principles involved have simply been extended to examining the influence on tax shifting of the amount and quality of reserves subject to the tax.

6.2.1.2 Other Taxes

Not all taxes on coal production are production-based severance taxes. In fact, even among severance taxes there is diversity not only as to whether the base is physical or dollar units, but, in the case of

value-based severance taxes, what (if any) production costs can be deducted from the taxable base. In addition to severance taxes, coal production is subject to most of the normal taxes any other business must pay. These include, among others, corporate income tax, permit taxes,and state and local property taxes. Little systematic study of the effect of these other taxes on coal extraction has been attempted. One study (Boyle, 1977) did examine state and local taxes separately in some western states and found wide variation in the shares of state and local taxes, as well as in their levels. As is developed in Section 6.1.3.1, these taxes probably would be borne by the resource owners rather than being shifted forward to consumers since coal is produced in a generally competitive industry. Rigorous treatment of this issue is made extremely difficult by the diversity of tax rates, bases, and jurisdictions.

6.2.2 The Owners of Coal

A major conceptual problem emerges in identifying the "coal owner." At least four separate groups exist that could be theoretically said to own the coal: (1) the legal owners who are normally thought of as the owner (the U.S. Government, land grant railroads, or private owners of mineral rights); (2) The leaseholder (usually the extractor) who owns the right to extract the coal during a specific period under specific terms; (3) the utility, which has the right to purchase the coal from the extractor for a predetermined price (predetermined because, typically, price escalations clauses[1] are tied to indicators beyond the control of either the

[1]The presence of "pass-through" clauses in long-term coal contracts, whereby mine operators automatically receive a higher price following the imposition of any new production tax, seems to be nearly universal. This was confirmed by Jeanette Studer, market analyst with Westmoreland Resources of Billings, MT; Phillip Zins, public utilities rate analyst, Public Service Department, state of Minnesota; Wayne Fox, Chief Electrical Engineer, Illinois Commerce Commission, state of Illinois; and Alexander Gakner, chief, Energy Fuels Analysis Branch, Office of Electric Power Generation, Federal Energy Regulatory Commission. All of these people are generally knowledgeable regarding practices in the industry, and Mr. Gakner has had occasion to read "several hundred" utility coal contracts. He cannot recall having seen one without a pass-through clause. Both Mr. Gakner and Ms. Studer remarked that the absence of such a clause would be much more likely in an "older" contract, signed before the recent revival in interest in coal and concerns for reclamation. Even without an explicit pass-through clause, the common use of a clause for the remedy of "gross inequities" might have the same effect.

extractor or the utility) for a specific period; and, (4) under certain conditions, utility customers. Except in economic terms, this last group would never be considered a coal owner -- quite the contrary. However, if the utility is obligated to purchase some amount of coal at a contract price (even if a lower price could be negotiated elsewhere), entitled to purchase some amount of coal at a specific price (even if the extractor could negotiate a higher price elsewhere) and must use this coal for the generation of electricity, then its customers theoretically share the same position as the legal coal owners. That is, in purchasing security for its customers by long term coal supply contracts, the utility puts them in a position to benefit when prices of electricity exceed the contract price and to incur higher than normal electricity costs when market prices are below the contract price.

If a severance tax is instituted during the utility's contract period, the tax is not borne by the legal owner of the coal, but is shifted forward to customers through rate increases. Given this analysis of incidence, a newly imposed severance tax will be shifted to utility customers, but only for existing coal supply contracts through the escalation clause. Of course, coal not under contract at the time of the imposition of the tax will also be affected. Here, the effective owner is the leaseholder, or the legal owner if the coal is not under lease. In either case, the willingness of buyers to purchase coal will not be affected (see Section 6.2.1 above) and so the coal "owner" will receive a lower price for his interest in the coal -- the tax is borne by the owner. In fact, after long run adjustments are complete, the tax will be borne entirely by the owners of the coal and will be paid from their rents.

6.2.3 Relevant Characteristics of the Coal Industry

The coal industry nationally certainly does not exhibit all the characterisitics of a perfectly competitive industry, but does at least approximate this model. In 1976, the four largest firms produced just 25.1 percent of total production: the eight largest, 34.2 percent; and the twenty largest, 49.7 percent (Charles Rivers Associates, 1977). These measures of concentration are commonly used as indicators of the extent of

competition in an industry. A small number of large producers constituting an industry does not mean that there is collusion, but a large number of small producers, as in agriculture, virtually guarantees the absence of organized production and price planning. The percentages cited for the coal industry suggest sufficiently large numbers of firms that an organization to control production would be very difficult to maintain. The firms that exist, moreover, are of sufficient size that competition among them for expanding markets need not be dominated by a few large companies. In addition, companies with extractive experience with other minerals might reasonably be expected to continue entry into the coal industry if the market continues to expand.

The concentration of buyers is somewhat greater. In 1969, the four largest utilities purchased 32 percent of all coal purchased by utilities; the eight largest, 45 percent; and the twenty largest, 67 percent. This, of course, excludes the non-utility coal users such as steel companies; but, these are currently not significant users of the low grades of coal found in the Old West Region.

If the use of coal by utilities is expanded, buyer concentration ought to be lessened. Further, increased ease of transportation has expanded the geographic market for Old West coal, which was once only local. This increases the competitiveness of the industry. Already Old West coal is shipped to Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Missouri, Oklahoma, Oregon, Texas, and Wisconsin, as well as being shipped across state lines within the region. In addition, considerable portions of the generating capacity installed or under construction in Old West states are planned for power export (MWRI, 1979). The industry adheres quite closely to the competitive model with respect to information, in that both buyers and sellers are knowledgeable about the product and alternatives.

The possibility of severance taxes in the Old West Region affecting a large portion of national production exists; although, this does not

now seem to be the case. Table 5-9 revealed that Montana and Wyoming, the two largest producing states in the region in 1977 contributed about 4 percent and 7 percent respectively of the national total. Extrapolating from Table 5-10 the DOE forecasted shares of national coal production for the Old West states under medium development scenarios are:

	Montana	North Dakota	Wyoming	Total Old West
1985	7.5%	2.6%	11.6%	21.7%
1990	19.2%	2.1%	15.2%	38.5%

While this is an increase, it does not appear that the Old West states individually will control what could be called a "dominant portion" of the market. The effect of state severance taxes on output is not clear. If coal extraction were otherwise unconstrained, the severance tax would cause rents on some (marginal) deposits to become negative, thus delaying extraction in those cases.[1] That is, if the resource owner's rent were less than the tax, the coal simply would not be mined. This was discussed in detail in Section 6.1.

In fact, though, coal production faces numerous other constraints. The construction of new coal-burning facilities or the conversion of facilities from other fuels to coal can be met with numerous regulatory delays, as can the opening of new mines and the construction of coal transport facilities. In the face of the potential delays, together with future market uncertainties (see Section 5.3), it is not clear that severance taxes would be able to play a decisive role in the rate of use of coal.

Table 6-1 presents data on total strippable reserves of coal in the United States. The data suggest that if the U.S. should become heavily reliant on coal, Montana and Wyoming would become dominant

[1] For a formal development of rates of extraction in competition, see Schulze, 1976.

producers of the mineral. Such dominance implies that coal market conditions could be influenced by the price effects of public policies in these states. This refers back to our earlier discussion of taxes placed on a significant share of the total products in Section 6.2.1.1.

TABLE 6-1

Demonstrated Surface Mining Coal Reserve Base of Old West States and the United States, by Sulfur Content (millions of tons)

Sulfur Content	≤1%	1.1 - 3%	>3%	Unknown	TOTAL
Montana	38,182.4	2,175.2	46.4	2,166.7	42,561.9
North Dakota	5,389	10,325.4	268.7	15.0	16,003.0
Nebraska	-	-	-	-	-
South Dakota	103.1	287.9	35.9	1.0	428.0
Wyoming	13,192.8	10,122.3	425.5	105.3	23,845.3
United States	73,252.3	33,597.4	18,950.9	11,076.1	136,885.7

Source: USDI Bureau of Mines, Mineral Land Survey, "Demonstrated Surface Mining Coal Reserve Base of the United States," May 1975.

With the possibility of a severance tax affecting market price, price elasticities of supply and demand should be at least approximated. Unfortunately, practices in the coal industry generally and the surface-mining coal industry especially are such that while competition seems to exist (Charles Rivers Associates, 1977), the concept of a market price has relatively little meaning. This is due primarily to the dominance of long-term contracts in the industry, with nearly all utilities obtaining most of their coal through this method (Charles Rivers Associates, 1977).

The multiplicity of prices in force at any particular time, coupled with the considerable lead times necessary for mine openings or expansions, create serious problems for the empirical determination of supply elasticities. Charles Rivers Associates estimated the price elasticity of supply, with price being average value at the mine for three short periods -- 1966-68, 1968-70, and 1972-75. The elasticities for those periods were 1.98, 1.20, and .33, respectively (Charles Rivers Associates, 1977). These short-run supply elasticities seem to suggest the potential for considerable supply responses to price changes, but requiring long lead times. The very low figure for 1972-75 could be interpreted as the inability of the coal industry to respond rapidly to the large price increases following the Arab oil embargo of 1973.

The price elasticity of demand by electrical utilities for coal has been estimated at -0.01 (Atkinson, Halvorsen, 1976). This number reflects both the inelasticity of demand by users of electricity and the very limited possibilities for substitution of other inputs for fuel. While the demand for electricity has generally been regarded as highly inelastic, it should be noted that present price trends will define portions of the demand curve in the near future not previously seen in the United States.[1] The experience of other countries suggests the opportunity for considerable observation in the U.S., in production process, output composition, and domestic use (Darstadler, Dunkerley, Alterman, 1977). To the extent that conservation is successful, the forecasted demand for coal will be The experience of other industrialized countries suggests that there is an opportunity for considerable conservation of electrical energy for industrial and domestic uses in the U.S. (Darstadler, Dunkerly, Alterman, 1977). To the extent that conservation is successful, the forecasted demand for coal will be altered since a major use of coal (and the primary use of Old West coal) is thermal electric power generation.

6.2.4 Summary of Conclusions

For coal supplied under long-term utility contracts in force at the time of a tax change, the increase or reduction in taxes will be shifted

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[1] See, for example, Richard L. Gordan, U.S. Coal and the Electric Power Industry, especially chapter 7, "Costs of Power Generation in the 1980's," Baltimore, 1975.

forward to utility customers. This shift is likely to approach 100 percent. Coal not yet covered by long-term supply contracts will decrease in value with the imposition of additional coal taxes and increase in value if taxes are reduced. The effective owners of this coal bear the tax change. They are the leaseholders and legal owners. Over the long run, if it becomes supply dominant in coal production, tax changes by an Old West state will be borne by the effective owners of the coal. If it is a dominant producer, some or all of the tax change will be shifted forward to utility customers in general through its effects on coal market prices.

Coal not yet covered by long-term supply contracts to utilities will decrease in value with the imposition of coal taxes. The effective "owners" of this coal bear the tax. They are the leaseholders and legal owners.

6.3 Tax Shifting in Practice: Empirical Estimates in the National Context

6.3.1 Overview

Recent legal challenges (see Chapter 1) have made the question of mineral fuels tax shifting extremely relevant to the current fiscal policies of the Old West states regarding their mineral resources. The comparative importance of these policies can only be understood in the national context of interstate tax shifting -- for all types of taxes. In this section we will examine the degree to which various taxes are exported by individual states and sketch the comparative performance of the Old West states for each type of tax. It will be seen that tax shifting is a pervasive phenomenon in which some states have been more successful than others.

As has been evident in this study, tax shifting is a very complex process. Uncovering and estimating the significance of tax exporting on a state-by-state basis is extremely difficult. It is readily apparent that many states have actively sought to shift local tax burdens to citizens of other states. As one tax expert in Florida

observed: "We have done an excellent job of shifting a large portion of the tax burden to tourists -- the tax system is designed to tax service industries quite heavily" (Donovan, 1969).

Despite the complex nature of tax exporting, it is possible to examine the ways in which various taxes are exported and to attempt some estimates of the amount of shifting that takes place. There has been some limited empirical work in this area by economists. In 1962, 25 percent of state tax collections were exported in the short run and 20 percent were exported in the long run. For some states, taxes exported were as high as 38 percent in the short run and as high as 34 percent in the long run. (McLure, 1966, 1967.)

To examine the broader consequences of such interstate fiscal impacts, it would be necessary to compare exported taxes to the benefit spillovers of state governmental spending. In other words, taxes are exported to citizens of other states, but so are the public goods and services provided by the taxing jurisdictions. It may well be appropriate in an equity sense for taxes to be exported to citizens of other states if these "foreigners" consume public goods or create governmental costs that are unique to the taxing jurisdiction. For example, it might be equitable for Florida (mineral fuel producing state) to tax tourists (consumers of these minerals) if these tourists (mineral consumers) are consuming public goods or creating costs for governmental units. These benefit spillovers occur because the geographic range of benefits does not coincide with the geographic boundary of governments. There have been no empirical estimates by economists as to the magnitude of these benefit spillovers.

The other unknown factor in the interstate fiscal impacts question is the degree to which taxes from other states are imported by each state. Again, empirical evidence is totally lacking. Taxes are imported when citizens of the state buy goods and services (tourism) in other states that have the other states' tax impacted on the price. Tax importation is, of course, the opposite of tax exportation. It needs to be pointed out, however, that the taxes imported and exported need not necessarily cancel out. Indeed, the most likely case is that there are net losers and net gainers in this shifting process.

Sections 6.1 and 6.2 of this report discussed the likely incidence of mineral fuels taxes in some detail with particular emphasis on the likely incidence of taxes on coal. It is possible, borrowing from McLure's methodology, to place these mineral fuels taxes in the broad perspective of the U.S. tax structure with its patchwork of different taxes (economists refer to this as "fiscal federalism"). To do this, it is necessary to sketch the mechanism for shifting as it relates to each major state tax and then to attempt some empirical statements as to the magnitude of such shifting. Following McLure, we will discuss taxes levied on individuals, taxes levied on production, taxes levied on consumption, taxes levied on corporations, taxes levied on property, and severance taxes.

6.3.2 Methodology

The remaining sections in this chapter are devoted to an estimation of the interstate exporting of taxes in the Old West states. Several other states are included as representatives of different areas so that the exportation of taxes in the Old West states can be put in relative perspective.

In estimating the tax shifting,we follow the methodology employed by McLure (1966, 1967) in his seminal work in this area. We update McLure by applying the tax export rate he used in his study based on 1962 data to 1977 data on state tax revenues. This is done for each of the taxes McLure examined in 1962. To repeat we will apply the export rate that McLure assumed to each present state tax. In other words,if states are shifting their relative tax collections to taxes that are more exportable,the share of each state's tax package that is exported will have increased since McLure did his study.

Secondly, we will examine several different scenarios about the export of mineral fuel taxes on coal in order to determine how sensitive the exportation of Old West states' taxes are to the assumed export rates. Finally,we will compare the relative and absolute amount of shifting in the selected states.

6.3.3 State Income Taxes

The major tax that states place on individuals is the state income tax. Income taxes are not the dominant form of state tax revenue, but state governments are increasing their use of income taxes. In 1976, an average 24 percent of state revenues came from state income taxes. This was up from 7.3 percent in 1962. While state income taxes do not dominate as a revenue source on the average, some states (i.e., New York) collect a substantial share of their revenue in state income tax. In absolute magnitude, state income taxes generated slightly more than $21 billion in 1976; but in New York alone, the state income tax generated almost $4 billion in revenue. In contrast, the Old West states combined collected about $250 million in such taxes in 1976. So the income tax generated about 40 percent of New York's state revenue and less than 10 percent of state revenues in the Old West Region. In the Midwest, there is a greater than average reliance on state income tax as a source of revenue: Michigan, nearly 30 percent; Wisconsin, nearly 40 percent; and Illinois, about 25 percent.

State income taxes are shifted in two ways. In the first case, individuals who earn income in one state while residing in another are taxed. For the most part, this is relatively insignificant except in states where large metropolitan areas cross state lines; that is, Washington, D.C. and Kansas City. By far, the more significant aspect of income tax exporting relates to the federal offset for deductible taxes. Since state taxes can be deducted from federal income taxes by those who itemize, the high state income tax is in effect borne by the federal taxpayers; that is, by citizens in all (other) states. In other words, states that generate more revenue through the income tax shift their federal tax burden to states that do not rely on state income taxes.[1] In this way, states such as New York, Michigan, and Wisconsin export their state income tax to the Old West states via the federal income tax offset.

[1] Obviously, this shift takes place over time and as a function of the degree to which federal income tax revenue shortfalls (due to state tax deductions) are made up by higher federal income tax rates.

6.3.4 Taxes on Production

Taxes on production are "cost taxes" in the sense that they are levied on inputs used in production or upon the production itself. Again following McLure, these include taxes on public utilities shifted to manufacturing, taxes on the purchase of inputs subject to sales taxes, taxes on motor fuels, and gross receipts taxes on mining.

Now, as we saw earlier in this report, the degree to which these production taxes can be shifted crucially depends on the industrial and geographic structure of the industry. For purposes of his study, McLure argued that the geographic concentration of production is the most significant determinant of the likelihood of tax exporting. Unless a state dominates the production of a commodity, the tax cannot be shifted forward. After geographic concentration the market structure of an industry is important. A tax levied on a monopolistic industry is more likely to be passed on, holding geographic concentration constant, than is a tax on a competitive industry. As a result, McLure adopted the following rule for his empirical estimates of the amount of tax shifting. If a state accounts for 40 percent of the national value added in production of a commodity, he assumes that the state is dominant enough that the tax is significantly shifted forward. Secondly, if the state accounts for 25 percent or more of the value added in an industry in which the largest four, eight, or twenty firms account for 50, 60, or 80 percent, respectively, of the value added in production, the firms in the industry are monopolized sufficiently to significantly shift cost taxes forward. These are admittedly imprecise rules concerning tax incidence, but they indicate the manner in which incidence studies are set up. Refer back to Section 6.2 to examine how the coal industry does by this rule for dominance. McLure proceeded by assuming that cost taxes are borne by local residents except in those cases where production in the taxing state is dominant in the national market. In national market production, McLure assumed that in the short run, cost taxes are entirely borne by profits when the market is not dominated, and are 60 percent shifted forward to consumers in the national market when the market is dominated. In the long run, his assumptions are different (based on incidence theory). He assumed that 60 percent of the cost

taxes impact on lower wages and rents. The other 40 percent is assumed to rest on profits in competitive industries and is shifted to consumers in the dominated industries.

In all of manufacturing, McLure found very few states that dominate in manufacturing (based on a four-digit SIC code). He found only seventeen states with any dominance in national markets; of these, only Michigan (autos) and North Carolina (tobacco) have a high degree of dominance. McLure took a special look at agriculture and mining; he found only three states that have dominance in any national agricultural market: California (fruit and nuts), North Dakota (flaxseed),[1] and North Carolina (tobacco). His findings for minerals are updated in Table 6-2. McLure assumed dominance in mineral products only for Arizona, Minnesota, Texas, and West Virginia. In all other states he found insufficient geographic dominance to allow shifting. An updating of the table to include the Old West states would not include any other states based on McLure's definition of dominance. For the four states noted above, McLure assumed 75 percent of severance taxes were shifted forward and 50 percent of mining taxes on coal property were shifted forward.[2]

Given these results for the national domination of production, McLure concluded that the only states in which significant shifting of production taxes takes place are Michigan, North Carolina, California, Arizona, Minnesota, Pennsylvania, Texas, and West Virginia. None of the Old West states fit into this category.

6.3.5 Taxes on Consumption

State governments rely heavily on sales taxes as a source of revenue. In 1976, 30.6 percent of all state revenues came from general sales or

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[1] This situation has changed as flaxseed production has fallen off drastically. However, by McLure's definition, North Dakota is presently dominant in the production of hard red spring and durum wheat and sunflowers.

[2] This assumption is important because later we will assume forward shifting of Old West states' severance tax even though the Old West states do not dominate production.

TABLE 6-2

Markets for Minerals Potentially Dominated by States

State	Mineral	% of State's Value Added in Mining	% of National Production
Arizona	Copper Ore	81.0	57.5
Minnesota	Iron Ore	92.5	65.3
Pennsylvania	Anthracite Coal	6.8	100.0
	Bituminous Coal	72.6	13.0
Texas	Petroleum	94.7	40.0
West Virginia	Bituminous Coal	94.6	16.9

Source: U.S. Bureau of the Census, U.S. Census of Mineral Industries: 1975, Vol. I, Summary and Industry Statistics, U.S. Government Printing Office, Washington, 1978.

gross receipts taxes. This was up from 14.6 percent in 1962. The Old West states were above the national average, collecting 31.3 percent of their taxes by this mechanism. States higher than the average include Arizona, 42 percent; Florida, 42.7 percent; Hawaii, 48.5 percent; and Nevada, 34 percent. These taxes include general taxes on consumption.

There are three ways in which these general sales taxes are exported to citizens of other states. They are exported most effectively by being levied against tourists; this fits the Florida model. A similar but distinct way of exporting is through commuter sales. The experience of the District of Columbia is a good example. But even in addition to tourism and commuter sales, these taxes often apply to industrial raw materials, tools and equipment used in production, and construction supplies. As a result, they enter the firm's costs and are in part exported through this vehicle.

McLure developed a detailed empirical model that attributed collections of sales on consumption to retail sales, wholesale sales, and estimated the amount of exporting due to tourism, commuter purchases, and export of manufactured goods by nationally dominated firms. The amount of general sales and gross receipts as a percent of all state and local taxes that are exported in the long run are arrayed in Table 6-3. The results are what one would expect a priori. The states that export these taxes tend to be the high tourism states and the states that dominate national production (i.e., Michigan). The Old West states are at the very bottom of the distribution of tax exporting by this measure.

The effect of specific excise taxes will be taken up next. Certain sales taxes and licenses taxes are levied selectively on a commodity basis and the revenue generating importance of these taxes varies widely by state. The most common of these taxes and most lucrative are those that are placed on motor fuel, motor vehicles, alcohol, and tobacco. Nationally, these alone accounted for 20.7 percent of total state collections in 1976. The reliance varies greatly by state with states such as Nevada (24%), Florida (26%), and Alabama (25%) being above average,

TABLE 6-3

The Long Run Exportation of General Sales and Gross Receipts Taxes as a Percent of All State and Local Taxes (1962)

Alabama	5.2	Missouri	3.1
Alaska	1.4	Montana	---
Arizona	6.8	Nebraska	---
Arkansas	4.9	Nevada	5.2
California	4.8	New Hampshire	---
Colorado	3.0	New Jersey	---
Connecticut	3.3	New Mexico	4.8
Delaware	---	New York	2.6
District of Columbia	4.2	North Carolina	3.7
Florida	4.4	North Dakota	2.0
Georgia	5.3	Ohio	2.8
Hawaii	8.7	Oklahoma	2.8
Idaho	---	Oregon	---
Illinois	5.3	Pennsylvania	3.6
Indiana	5.3	Rhode Island	3.1
Iowa	2.7	South Carolina	4.3
Kansas	3.2	South Dakota	2.1
Kentucky	4.4	Tennessee	4.6
Louisiana	3.6	Texas	1.8
Maine	3.0	Utah	4.1
Maryland	2.8	Vermont	---
Massachusetts	---	Virginia	---
Michigan	5.3	Washington	7.0
Minnesota	---	Wisconsin	0.3
Mississippi	5.7	Wyoming	2.9

Source: C. E. McLure, "An Analysis of Regional Tax Incidence, with Estimates of Interstate Incidence of State and Local Taxes," Princeton Ph.D. 1966, University Microfilms, pp. 198-200.

while California (14.3%) and Wisconsin (15%) are below average. The Old West states combined are above average collecting 28 percent of their state taxes on these selective taxes.

The way in which these taxes are shifted to out-of-state residents is obvious. Almost all states levy taxes on public utilities that then become part of the rate base. States that export this power are exporting the tax. States such as Arizona and New Mexico that export electric power have a great potential for tax exportation. The U.S. Supreme Court has recently ruled that taxes placed only on the exported power are illegal,[1] but this says nothing about taxes that are generally placed on all production which is domestically consumed and exported to other states.

Perhaps the tax in this category of special taxes that has the most potential for exportation is the tax on alcoholic beverages. This is quite clearly a tourist tax, and as McLure showed, heavy tourist states shift a surprisingly large share of their tax in this manner. Florida, for instance, exported 27.5 percent of this tax which effectively represents a shift of 2.1 percent of the entire Florida state revenue. Nevada similarly exported 31.8 percent of its liquor tax representing 2.4 percent of the state's revenue. McLure's results show a contrast between the exporting of these high tourism states and the Old West region where he reported that Montana only shifted 0.2 percent of its state taxes in this manner (North Dakota, 0.2%; South Dakota, 0.5%; Nebraska, 0.5%; and Wyoming, 0.5%). In other words, Nevada exported its state taxes via this mechanism at 1200%, the rate that Montana did.

Motor fuels taxes are exported in two ways. Of course, tourists pay this tax so that states with higher than average vehicular tourism will export a higher than average amount of this tax. Motor fuels also enter production costs and are therefore shifted forward by the amount that any state dominates production in any commodity, in the same way we discussed earlier.

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[1] The most recent court decision on this issue was discussed in Chapter 1.

Still another way to export taxes via a special tax is by use of a whole array of recreational and miscellaneous taxes including special license fees. The all-time winner in this category is Nevada with Florida as a distant second. McLure reported that Nevada shifts a full 14.1% of its total collections to non-citizens by the use of such taxes. The Old West states by comparison exported very small amounts by this revenue source: Montana, 0.6 percent; Nebraska, 0.0 percent; North Dakota, 0.0 percent; South Dakota, 0.9 percent; and Wyoming, 1.7 percent.

6.3.6 Taxes on Corporations

Taxes on corporations, the corporate income tax, is a relatively small but growing tax at the state level. In 1962, the corporate income tax represented 3.1 percent of all states revenue;but by 1976, this share had increased to 8.1 percent. In the past, states have been reluctant to enact such taxes because of the complexity of administering taxes on entities which span many political subdivisions. Also the use, or rather non-use, of this tax was seen as an instrument to attract industry. The Old West states rely very little on this tax, collecting on average only 5 percent of state revenue by corporate taxes in 1976. (Wyoming collected no corporate income taxes.) This compares to a high of 40 percent for Delaware with California and New York collecting 11.9 percent and 11.6 percent respectively of their revenue of corporate income. The absolute magnitude of the amounts are often blurred by the relative comparisons of percentages. For example, in 1976, the Old West states combined collected $74 million in corporate income taxes while California alone collected $1.28 billion in corporate income taxes, more than seventeen times more than the Old West states combined.

The shifting of this tax is the most theoretically complex. Academic careers have been spent debating the issue, which is still a current topic of debate. Traditional theory indicates that the tax cannot be shifted in the short run. The argument is simple enough. The tax does not change marginal costs or marginal revenues so it cannot alter the profit maximization output decision. This solution has been challenged in cases where firms are not pure profit maximizers.

In the long run, the results are different because capital can migrate; the presumption is that the tax can be shifted to consumers and owners of factors of production. The exact determination of the amount of shifting depends upon the interest elasticity of saving and investment, the production function, and the demand for the products themselves. McLure assumed that in the long run in national manufacturing, 60 percent of the tax was borne by land and labor in the taxing state with the other 40 percent shifted to consumers if the manufacturing is state-dominated, but borne by profits if it is not state-dominated.

McLure then examined a tremendous volume of data to determine the estimates of the degree of state exporting in the long run. His results indicated that Delaware exported 15 percent of its state collections via the corporate income tax; North Carolina is a distant second with 4.2 percent. California, Michigan, and New York exported 2.4 percent, 1.3 percent, and 2.7 percent of their total state collections respectively. This compares to an average in the Old West states of .46 percent of total collections.

The absolute magnitudes are again worth noting to keep a perspective on real levels of tax exporting. If McLure's results are generalized to 1976 data,it would mean that California shifted $258 million to taxpayers outside of California via the corporate income tax. This is more than tax collections of Wyoming in 1976 and almost equal to Montana's total collections. The Old West export of corporate income taxes would have only been $6.6 million in 1976, which makes the California export amount 39 times the rate in the entire Old West Region.

6.3.7 Property Taxes

The property tax is the most important source of revenue for local governments. We have until this point been referring to tax collections of state governments; but when we combine state and local government, we find that 36.3 percent of all state and local revenue from own sources of revenue (no revenue sharing) came from the property tax in 1975. Local revenue is almost exlusively generated from property taxes. California collected $7.9 billion in 1975 property taxes,and New York collected $6.7 billion. This represented 42 percent and 36 percent of

the own revenue generated by state and local governments. In the Old West states, a total of $1.07 billion in property taxes were collected in 1975, representing 45 percent of state and local tax collections.

The property tax refers to a large number of different taxes levied on real and personal property. McLure made the following assumptions when dealing with property taxes. He assumed that taxes on railroads and public utilities are shifted forward to users of these services. Taxes on commercial property are borne by consumers, and taxes on rental property are paid by renters. The property tax on private homes is assumed to be paid by the owners, but a federal offset is calculated, much as in the case of state income taxes. Finally, McLure treated property taxes on mining as a tax on rent. He did allow, however, for some forward shifting in the case of state-dominated markets. He assumed 50 percent forward shifting for Arizona and Texas, and 25 percent forward shifting in the other state-dominated markets (see Table 6-2 for these state-dominated markets).

In his complex empirical evaluation, McLure rated Wyoming, Montana, and Arizona as the top states in property tax exportation with 13.4 percent, 13.2 percent, and 12.2 percent of all state and local collections being exported via the property tax. In Wyoming, the railroad tax is important in this high relative ranking, and in Arizona the state dominated copper industry is significant. McLure ranked the Old West states in order: Wyoming (13.4%), Montana (13.2%), Nebraska (12.1%), North Dakota (10.6%), and South Dakota (8.5%).

The relative rankings, however, should not obscure the absolute amount of tax shifting that is going on via the property tax. If McLure's results are generalized to 1977 tax collection data, we see in Table 6.3 that although the Old West states rank high as relative exporters of the property tax, the absolute amount of taxes shifted to other states is minimal when compared to some other states. In all the Old West states combined export $291 million in property taxes, less than any of the other states in Table 6-4, listed singly.

TABLE 6-4

Exported Property Taxes[a]

State	Millions $
California	1,911
Michigan	888
Illinois	928
Wisconsin	341
Montana	76
Nebraska	107
North Dakota	30
South Dakota	31
Wyoming	47

Source: U.S. Bureau of Census, State Tax Collection, U.S. Government Printing Office.

[a]Projections based on 1977 data and McLure's estimates of the rate property tax shifting.

6.3.8 Severance Taxes

McLure argued that severance taxes are one of the most efficient vehicles for tax exportation. If the state produces a substantial portion of the mineral that is being taxed, the tax may be shifted forward to consumers. He pointed out that if the demand for a particular state's exports is elastic, and we saw earlier in this chapter that this is the case for coal (i.e., the industry is competitive), the tax is not shifted or at best incompletely shifted. Even in the case of a competitive industry there is some shifting due to the fact that owners may be non-citizens of the state and that portion that is borne by citizens may be federally offset much like the state income tax.

McLure calculated the exporting of severance taxes in the following way. In states (5) in 1962 where the severance tax contributed more than 6 percent of state revenue, he made the following calculations based on theoretical presumptions. He assumed residents bear one-half of the burden in Alaska, Louisiana, New Mexico, and Oklahoma, and one-fourth the burden in Minnesota and Texas. In other states using a severance tax, he assumed that 25 percent of it was exported. A critical decision in the computation was whether or not the state dominated production in that mineral. In Minnesota and Texas, the combination of state dominance and high levels of concentration in the iron ore and petroleum industry merit the high export rate. The bituminous and lignite industry in the U.S. is not concentrated nor, as we saw in Section 5.3, do any of the Old West states dominate production in a geographic sense. Table 6-5 shows 1977 data on state production. As a result, McLure would calculate the exportation of the most recent severance tax on coal in Old West states as, at most 25 percent. In the next subsection, various calculations about severance taxation will be made for the Old West states, assuming in one case that 100 percent of the tax is exported. It should be pointed out here that in McLure's "worst case" only 75 percent of the severance tax is exported.

6.3.9 An Update of McLure's Estimates and a Relative State Comparison of the Amount of Tax Exporting

In this section we update the results of the McLure study using 1977 data on state and local tax generation. We proceed by assuming the same rates of exportation on individual taxes that McLure used. The

TABLE 6-5

State Market Share in Production of Bituminous Coal and Lignite (1977)

State	U.S. (%) Production	Underground and Surface Production (000 tons)	Percent Change 1976-77
Alabama	3.1	21,220	- 1.5
Arizona	1.7	11,475	+10.1
Colorado	1.7	11,920	+26.3
Illinois	7.8	53,880	- 7.5
Indiana	4.1	27,995	+10.4
Kentucky	20.8	142,945	- 0.7
Montana	4.2	27,226	+ 3.8
North Dakota	1.8	12,028	+ 8.4
Ohio	6.7	46,205	- 0.8
Pennsylvania	12.1	83,225	- 3.0
Virginia	5.5	37,850	- 5.4
West Virginia	13.8	95,405	-12.3
Wyoming	6.5	46,028	+49.8
TOTAL U.S.	100.0	691,344	+ 1.9

Source: McGraw Hill, 1978 Keystone Coal Industry Manual, New York, N.Y.

changing structure of tax incidence and tax exportation will thusly be determined by changing mixes of tax composition in individual states. In other words, states that become more reliant on taxes that are more exportable will be seen to shift a larger share of their state collections to citizens of other states.

A crucial assumption in this exercise is that the underlying economic relationship that formed the individual tax exportation rates are unchanged. This is a heroic assumption, but one which is no more heroic than most used in other studies of tax incidence. The assumptions on which these original rates were based are made on the best presumption from the economic theory of incidence. It should be recognized that the numbers in themselves have to be viewed with a great deal of skepticism. The purpose of the analysis is to show how taxes are exported and to view the relative character of these shifts. What emerges is that tax exporting is a very pervasive phenomenon and one which some states (state legislatures) pull off more effectively than others.

Tables 6-6 and 6-7 show the amount of state collections for selected states that were exported in McLure's study based on 1962 tax data and our update for the same states using 1977 data in tax collections.

The results of the 1977 update are revealing. Of the eleven states examined,all but Montana, Nevada, and Wyoming have increased the share of state collections that are exported to residents of other states in the long run. The range of exports rates is fairly tight with most states exporting about one-fourth of their taxes in the short run and one-fifth in the long run. The absolute numbers are also worth noting. California, for example, exports $5.8 billion in the short run and $4.8 billion in the long run taxes to other states. This is more than the entire state collections in the Old West states. In fact, the amount of selective sales taxes exported by Michigan ($207 million), Illinois ($381 million), and California ($439 million) exceeds the entire short run amount exported from all taxes in the state of Montana ($148 million).

TABLE 6-6

The Interstate Incidence of State Tax Collections
Short Run

State	1962 Value of Exported Taxes (Million $)	1962 Percent of State Taxes Exported	1977 Value of Exported Taxes (Million $)	1977 Percent of State Taxes Exported
California	1,208.6	23.5	5,791.6	24.3
Florida	214.4	20.2	1,074.5	20.2
Illinois	622.9	25.3	2,541.3	26.2
Michigan	557.5	29.4	2,448.4	31.2
Montana	39.7	24.5	147.7	25.4
Nebraska	50.3	18.6	261.7	21.6
Nevada	34.6	36.3	196.7	34.8
North Dakota	27.0	20.0	92.9	21.1
South Dakota	25.9	17.0	72.6	17.0
Wisconsin	240.7	24.7	974.4	24.2
Wyoming	21.1	25.8	101.6	25.1
Weighted Average		24.8		25.6

TABLE 6-7

The Interstate Incidence of State Tax Collections
Long Run

State	1962 Value of Exported Taxes (Million $)	1962 Percent of State Taxes Exported	1977 Value of Exported Taxes (Million $)	1977 Percent of State Taxes Exported
California	1,002.9	19.5	4,781.6	20.0
Florida	199.5	18.8	1,088.6	20.4
Illinois	509.6	20.7	2,082.2	21.5
Michigan	403.9	21.3	1,716.8	21.9
Montana	35.5	21.9	124.2	21.3
Nebraska	46.8	17.3	290.0	23.9
Nevada	33.2	34.9	187.1	33.1
North Dakota	25.0	18.5	85.4	19.4
South Dakota	24.8	16.3	70.8	16.6
Wisconsin	170.6	17.5	741.1	18.4
Wyoming	19.1	23.3	91.5	22.6
TOTAL	2,470.9	20.0	11,259.3	20.8

Figure 6-9 depicts the change in the short and long run rates of state tax exports for the 1962-1977 period, based upon the data presented in Tables 6-6 and 6-7. Among all states examined, Nebraska exhibited the greatest increase in tax exporting. By 1977, its share exported was still below the average for the selected states in terms of short run effects, but had risen above the average for long run effects. Of the other Old West states, only North Dakota showed above average increases; however, it still remained below average in terms of actual share exported. For the eleven states examined, the average share of state taxes exported increased an estimated 3.3 percent in the short run and 4.0 percent in the long run during the 1962-1977 period.

It is interesting to consider the effect of different assumptions regarding the incidence of the coal severance tax in Montana, North Dakota, and Wyoming. If we assume the coal tax is 100 percent exported (this even excludes any coal consumed in state), the value of the exported tax in 1977 is $43 million (Montana), $15 million (North Dakota), and $47 million (Wyoming). Table 6-8 calculates the increase in the tax package export rate when the severance export rate is increased to 50 percent, 75 percent, and 100 percent. If we assume the most extreme position that 100 percent of the severance tax is exported, the long run export rates increase to 27.0 in Montana, 31.4 in Wyoming, and 22.2 in North Dakota. So even if the worst case scenario is selected, which violates McLure's assumptions, these states do not approach the highest (Nevada) nor are they significantly different from the other states examined.

6.3.10 Absolute, Relative, and Per Capita Magnitudes

A few words should be said about the comparisons made between the figures. Typically in economic analysis we make relative comparisons between countries or states when dealing with economic data. Following this tradition the percentage comparisons in Tables 6-6 and 6-7 would be used. We, however, often made reference to the absolute magnitudes which showed the larger states (i.e., California) dominating in the export of taxes. This was done because of the fact that we do not

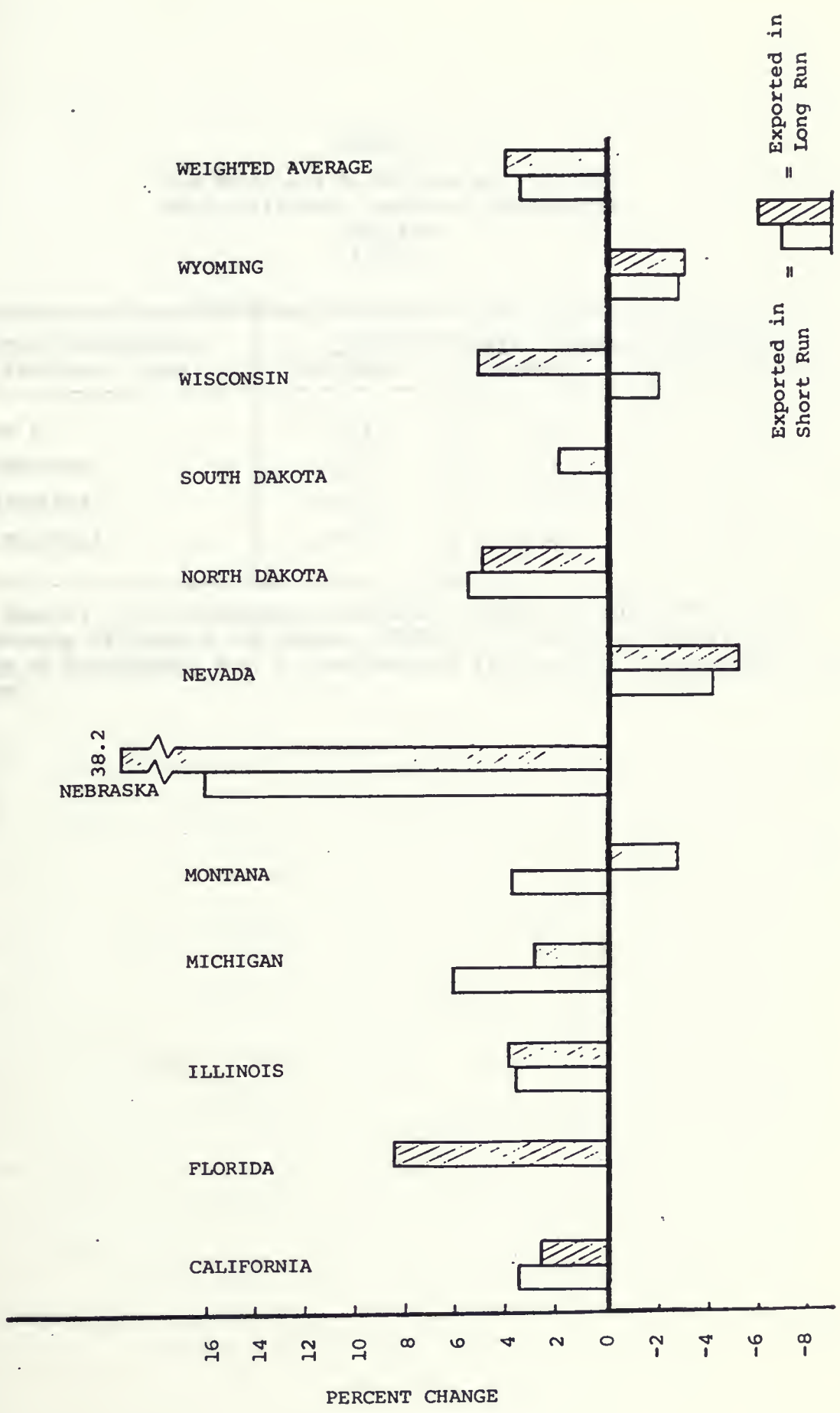

FIGURE 6-9
Change in the Proportion of State Taxes Exported
1962-1977

TABLE 6-8

Tax Exporting in Montana and Wyoming
Given Different Incidence Assumptions
Long Run
(1977)

Incidence Assumptions For Severance Taxes	% of Total State Collections Exported		
	Montana	Wyoming	North Dakota
McLure's	21.3	22.6	19.4
50% Exported	23.3	25.5	20.5
75% Exported	25.2	28.4	21.3
100% Exported	27.0	31.4	22.2

Source: U.S. Department of Interior, Bureau of Mines, Minerals in the Economy of Wyoming and Montana, 1978; U.S. Bureau of Census, 1977 Census of Government, Vol. 4, Governmental Finance, U.S. Government Printing Office.

have data on the importation of taxes. As we discussed earlier, states also import taxes. These taxes are incorporated in the prices of goods purchased from other states. As a result the Old West states may or may not be losers if they import large numbers of goods from high export states such as California and Michigan. Unfortunately, we do not have figures available that allow such an examination, but the absolute numbers give a rough, impressionistic feel for the opportunity for such importing.

Still another way to judge relative rankings of different magnitudes is on a per capita basis. Table 6-9 does this for the long run exportation of taxes. By this measure the Old West states (except Wyoming) appear to export a below-average share of their tax revenue.

6.3.11 The Political Economy of Tax Shifting

Taxes which can be exported are politically more palatable. Legislators are able to generate revenue to finance programs and transfers which earn them votes with the public while minimizing the ire that the taxes that go with these expenditures provoke. Indeed, from the point of view of a legislator this is the ideal taxing scheme; in effect transfers can be generated from non-voters in other states to voters in the state. It appears that many bureaucrats and politicians ascribe to the philosophy reflected in this section's opening quote from the Florida official; for most states, at least those in the sample examined, increased their rate of exporting from 1962 to 1977. Since McLure's export rates were used to calculate the amount of exported taxes in 1977, the increased rates reflect an increased state reliance on taxes that have higher propensities to export. Whether or not this is a conscious exercise on the part of state legislatures is best left to the realm of the political scientist. The economist can only point to the powerful incentives that exist to push the state tax package on "foreigners"; that is, non-voters. In absolute dollars, California is the master, exporting more than a billion dollars to non-voters in 1977 (Table 6-6). California seems to have mined its agriculture, industry, beaches, and weather very effectively.

TABLE 6-9

Per Capita Long Run Tax Exportation

State	1977 Population 000s	1977 Tax Exportation Million $	Per Capita Taxes Exported
California	21,896	4,781.6	218
Florida	8,452	1,088.6	128
Illinois	11,245	2,082.2	185
Michigan	9,129	1,716.8	188
Montana	761	124.2	163
Nebraska	1,552	290.0	186
Nevada	683	187.1	274
North Dakota	653	85.4	130
South Dakota	689	70.8	102
Wisconsin	4,651	741.1	159
Wyoming	406	91.5	225

Source: Population estimates from Statistical Abstract of the U.S. 1978, U.S. Department of Commerce, Bureau of Census, 1978; tax exportation from Table 6-7.

6.3.12 Summary

This chapter has sought to examine and highlight the earlier theoretical discussion of tax incidence and tax exporting. Preceding chapters of this report discussed taxation in a theoretical setting. The real world truth of tax incidence research is that it is a messy undertaking. In many or most cases, with so many market participants trying to shift taxes to other market participants, it is very difficult to conclude with any degree of certainty who pays what tax.

This chapter, using established and theoretically-based assumptions concerning tax incidence, has consistently applied these assumptions to tax data in an attempt to determine, or to better shed light on, the question of tax exporting in the U.S.

The conclusion of this exercise is a simple, but very important fact. Tax exporting in a fiscal system based on federalism is a very pervasive phenomenon. Strong political incentives exist for political leaders to shift taxes to voters in other states. The evidence indicates that everyone is doing it to everybody. An important question emerges from this fact: Who is gaining and who is losing? The question is, at present, impossible to answer. It would be necessary to determine how the benefits of state spending spill over into other states. It would also be necessary to determine the degree of tax importing. This would require unavailable data on the importation of goods and services between states. We do not keep balance of payments figures on a statewide basis -- perhaps it is a good thing.

7. THE COSTS IMPOSED BY MINERAL FUEL DEVELOPMENT IN THE OLD WEST STATES: THE CASE OF COAL

7. THE COSTS IMPOSED BY MINERAL FUEL DEVELOPMENT IN THE OLD WEST STATES: THE CASE OF COAL

As we have seen in earlier chapters, tax systems in the United States are predominantly based upon ability-to-pay criteria. One of the policy challenges to mineral fuels taxation in certain Old West states is that the levies are far in excess of (1) the benefits provided by the state to the taxpayer(s), and (2) the costs that the resource development imposes on the state.[1] In essence, this argument assumes benefit criteria to be the appropriate bases for severance taxes. Putting aside, for the moment, the issue of whether or not benefit criteria are appropriate, their utility obviously depends on the extent to which the "benefits" and costs of coal development can be quantified.[2] User charges like fuel taxes and highway tolls are similarly based on benefit criteria. A significant body of empirical evidence and economic theory is available to quantify road user costs -- hence, appropriate charges. To what extent do corresponding evidence and theory exist for mineral fuels development? In this chapter we shall attempt to answer that question, focusing on examples from coal development.

What benefits do Old West states provide to mining companies and other owners of coal production, and what costs does coal development impose on those states and their citizens? On the benefits side, the states provide an organized society in which coal resource developers are able to assemble the factors of production, extract the resource, and deliver it to the consumer. State and local governmental jurisdictions provide police protection, an organized legal framework within which to do business, and a wide variety of services and facilities for the

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[1] This is one of the arguments advanced in the legal suit brought by Consolidated Edison, et al. against the state of Montana.

[2] It may be interesting to examine the overall economic effect of coal mining activities using social benefit/cost analysis. However, such research is beyond the scope of this study. Moreover, it exceeds the bounds of information that the state would theoretically need in order to establish levels of mineral fuels taxation commensurate with the costs imposed and benefits received.

individuals employed at the coal development firms. Since in this analysis, many of these direct "benefits" are more palpably considered as costs imposed on state or local governmental entities, the focus on our analysis will be on the cost question. As for the benefits of an organized society in which to do business, how are they to be evaluated? If their valuation were feasible, what portion would be attributable to federal, state, or local governmental entities, respectively? While economic theory and a host of assumptions might be called upon to make estimates of benefit values (in terms of net decrease or increase in GNP, for example), the empirical evidence to support such estimates is wholly lacking. We therefore leave the question of benefit valuation and turn to the issue of costs.

The body of this chapter is concerned with two types of costs: (1) those associated with the social overhead or public goods needs of the population due to coal development, and (2) economic externalities or social costs generated by coal development. The first category concerns the incremental costs of meeting the mine-related population's demand for public services and facilities. These include the public expenditure requirements -- for public safety, health, education, recreation, sanitation, transportation, and administration -- typically addressed in fiscal impact assessments of resource development proposals. Social overhead costs are typically imposed on state and local governmental jurisdictions and are therefore commonly seen as the direct expenditure justification of mineral fuels taxes. The second category, economic externalities, is also termed external economies/diseconomies, third-party effects, spillover effects or social effects.[1] Externalities are defined as "Effects upon persons not associated with specified purchases or activities..." (Davis, 1972). In the case of coal mining, this means effects on individuals, whether mine workers or others, that are not reflected in the mining firms' costs of production. Some social overhead costs are externalities. However, in this discussion, externalities or social costs are used to refer to effects which are generally difficult or impossible to quantify, but nevertheless affect a state or

[1]These may be positive or negative. Our analysis is primarily concerned with negative effects or external diseconomies.

local governmental entity's economic or social welfare responsibilities over the long run (in terms of cost, revenue, and tax relief[1]), and affect the welfare of individuals not directly connected with the mining activity. Examples of external costs are the health effects of air pollution, reduction in a community's quality of life, and the psychological stress on individuals due to rapid change in their surroundings.

The analysis of social overhead costs has become a common feature of most impact assessments of western mineral resource developments. In these impact studies, social overhead costs are typically considered within a fiscal analysis framework. Since, (1) it has become so commonplace, and (2) its results are expressed in budgetary dollars and cents, fiscal impact analysis is frequently assumed to yield reasonably accurate results. However, as we shall see in Section 7.1 below, this is far from the case. A variety of analytic obstacles remain to be overcome in economic theory and further, much of the necessary empirical data with which to validate the theory is still lacking. While Section 7.1 summarizes the state-of-the-art in fiscal impact analysis, a more detailed discussion is presented in Appendix B.

With the exception of fiscal burdens imposed on local governmental entities through induced population effects, the fiscal burdens and economic responsibilities attributable to the externalities associated with coal development have been wholly neglected in impact analyses. There is good reason for this neglect. Many of the factors involved are virtually unquantifiable. Section 7.2 explores the question of coal development externalities as well as the state-of-the-art in measuring them and their effects.

Finally, the relative importance of the sum of social overhead costs and externalities to state and local governments must be addressed. This is the subject of Section 7.3. The conclusion reached is that, although the value of most of the economic externalities cannot be

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[1]Tax relief is one of the few mechanisms that state government has at its disposal to compensate present and future generations of citizens for negative externalities such as the economic and social effects of environmental degradation and industrial intrusion. This question is addressed in greater detail in Section 7.2.

meaningfully quantified, they might greatly exceed the social overhead costs traditionally estimated in impact assessments.

7.1 Social Overhead Costs

The estimation of social overhead effects of a particular mineral fuel development -- project or program -- has traditionally been carried out as some form of net fiscal impact on local governmental jurisdictions. In order to determine the extent of net fiscal impact, the total economic/demographic effects of the development activity must be determined (estimated) and distributed over time and space. The public facilities and services needs implied by the population effects are then estimated, followed by an assessment of the land use requirements of the resultant residential, facilities/services, and commercial/industrial changes. The magnitude and location of all these needs and requirements are key inputs to the assessment of the fiscal impacts on each relevant governmental unit.[1] Figure 7-1 presents a simplified sketch of the steps leading to fiscal impact determination.

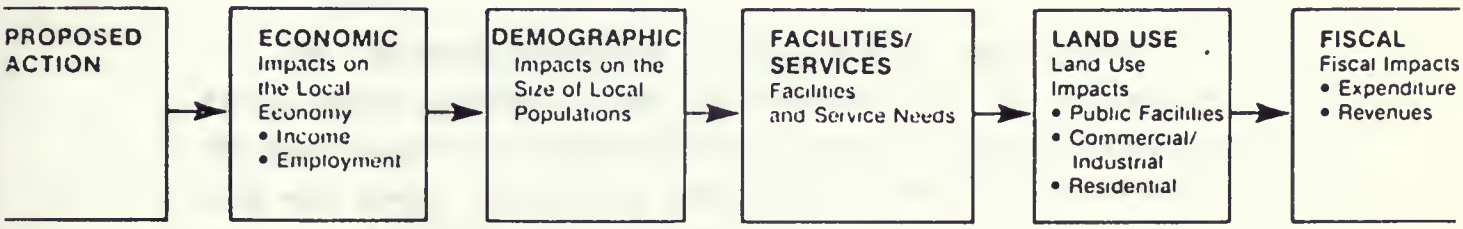

FIGURE 7-1. Steps leading to fiscal impact analysis

Social overhead costs borne by state and local governments have usually been associated with the last block -- fiscal effects -- in Figure 7-1. These costs may pertain to increased expenditures in a

[1] Most fiscal impact assessments of proposed coal developments have omitted any comprehensive evaluations of impacts at the state level.

number of categories across several governmental jurisdictions, or they may pertain to revenues which do not increase in proportion to expenditures. The ability of the analyst to estimate direct fiscal effects clearly depends upon the accuracy with which the preceding analytic steps illustrated in Figure 7-1 can be carried out. Current techniques employed in these analytic steps are very imprecise. The primary factors responsible for this imprecision are: (1) a lack of empirical data regarding key elements of the economic/demographic impact process, (2) the inadequacy of the economic/demographic forecasting tools presently available for essentially rural areas such as those locations in the Old West Region where coal development has been taking place, and (3) the inability of economists or anyone else to forecast important but unanticipated events.[1]

The subsections below document the predictive problems associated with each step leading to fiscal impact assessment. Where fiscal impacts are small relative to existing revenues and expenditures, the error of estimate is not of crucial significance. However, the larger the impact relative to current fiscal condition, the more significant the error of estimate becomes.

The remainder of Section 7.1 will provide an overview of the entire fiscal impact process -- from the description of the proposed action to the final result -- highlighting the technical uncertainties associated with each step. For ease of presentation, the entire assessment process illustrated in Figure 7-1 is collapsed here into two steps: (1) all those steps which precede fiscal assessment (of which economic/demographic relationships are the key determinant), and (2) fiscal impact assessment itself.

Section 7.1.1 provides a brief review of the techniques and problems associated with economic/demographic impact estimation, illustrated with appropriate examples from existing literature. Section 7.1.2 describes

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[1]The level of detail and theoretical purity of large-scale economic and demographic forecasting models is of little help on this point. For example, almost none of the national econometric models were able to forecast the level of inflation presently being experienced in the United States.

a similar exercise for fiscal impact estimation. Section 7.1.3 describes an idealized fiscal impact model based on the previous discussions, while Section 7.1.4 presents results from existing fiscal impact analyses. Finally, Section 7.1.5 summarizes the present state-of-the-art in fiscal impact assessments. A more detailed discussion of these points is presented in Appendix B.

7.1.1 Economic/Demographic Relationships

The translation from a description of the proposed action to an estimate of the fiscal impact of the action proceeds through the several causally related steps illustrated in Figure 7-1. Because complete information on economic/demographic relationships does not exist, each of these steps is estimated based on assumptions made by the analyst and on the results of the prior step. The final result -- an estimate of fiscal impact -- is highly sensitive to the key assumptions, since any error can be magnified by the sequential structure of the analysis. Specific techniques, problems, assumptions, and results of economic/demographic estimation are discussed briefly in Section 7.1.1.1 below.

The analysis is further complicated, however, in that local economic, population, and fiscal conditions are dynamic, and may be growing, declining, or remaining stable irrespective of the proposed action. Effects of the proposed action will interact with other future environmental conditions in the locality. This issue is discussed in Section 7.1.1.2.

The basis for socioeconomic impact assessment, in general, and fiscal impact analysis, in particular, lies in the population and income changes stimulated in the economy (local and regional) by a given mineral development. Consequently, the demographic component of the analysis focuses on the determination of population and income effects attributable to the development.

7.1.1.1 Economic/Demographic Estimation

State and local government revenues and expenditures are functions of political, economic, and demographic variables in the region which

those governments serve. Fiscal impact cannot, therefore, be reasonably estimated without prior estimation of the economic and demographic impact of a particular development. "Economic/demographic estimation" is used here in a broad sense to include facilities/services impacts and land use impacts. However, as mentioned above, the driving variables producing these impacts are income and population change.

Conceptual approach. Local impact begins with the proposed action; the most immediate effect of which will be the employment associated with the project. Typically, only a portion of the employment requirements will be supplied by local labor. To the extent that local labor availability is inadequate (in number, skills, and/or union affiliation) to fill the employment opportunities, inmigration of labor will result.

The proposed action will have another impact -- purchases of materials, equipment, and services from local and regional suppliers. Such purchases can cause increased employment and income in the vicinity of the supplier, which does not necessarily correspond with the vicinity of the proposed action. This effect may take place over time. A development such as coal mining, for example, may cause secondary economic development by gradually attracting other new industries and businesses which service it. Their employment and income impact can occur in other communities within a larger trading region. However, it is extremely difficult to forecast the precise location of such new industries.

Population and businesses attracted by coal development will purchase goods and services. As a result, trade and services will also expand, increasing job opportunities and causing further inmigration. Two types of secondary development, therefore, will occur; that directly related to coal development (basic activities), and that which produces goods and services consumed by the local economy (nonbasic activities).

It was noted above that new employment generated by purchases of goods and services by the mining activity may not be located in the immediate vicinity of the activity. This is one example of the

importance of the spatial dimension in impact assessment. It is important to understand the spatial distribution of new basic employment related to coal development because the location of consequent new nonbasic employment must be derived from this distribution.[1] This nonbasic employment growth is further influenced by where basic workers and their families spend their income. The spatial economy of the Old West Region is characterized by a hierarchy of trade and service centers, each offering a greater variety of goods and services as they increase in size (Woerner, 1975; Chalmers, et al., 1978; Borchert, Adams, 1963; Rust, Alonso, 1978). Market areas of centers which offer different levels of goods and services overlap. Thus, while coal development is likely to be located in a rural area -- the trade center of which may offer a minimal variety of (essential) goods and services -- coal development employees who choose to reside in that same center will likely travel to other trade centers for higher-order goods and services such as durables and medical services. Trade and services, therefore, will expand in higher-order trade centers as well as in the lower-order trade centers where the resource development is actually occurring.

The total number of jobs created by coal development and its associated secondary development is likely to cause employment-related migration to occur, and at the same time increase the local labor force participation rate. Working migrants will be accompanied by families. The population grows through natural increase as well as through migration. The vital rates that determine this growth are functions of a number of factors. It is very likely that vital rates will differ between long-time, pre-development residents and development-attracted inmigrants.

The total increase in population will generate increased demand for facilities and services. Increased demand does not necessarily imply that it will be met by expanded supply because of various lags, particularly for public services. The land use distribution of new housing,

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[1] A further example is the residential distribution of mine workers. Inmigrating, nonlocal workers are likely to distribute themselves among all of the reasonable residential community choices within commuting distance of the work site.

industry, and commercial and public facilities has bearing on fiscal impact -- capital and operating costs increase with low density development, while different millage rates apply to different land uses, so that the land use mix will influence property tax revenues.

Finally, even without the proposed action, the economy may still change -- whether growing, declining, or stable. It is necessary, therefore, to forecast employment change in the absence of coal development from which forecasts of population change, facilities and service demand, and land use distribution follow. These forecasts are compared with their counterparts under the coal development forecast scenario to calculate the net impact due to coal development alone.

Technical difficulties. The implementation of economic/demographic estimation is characterized by chronic data unavailability, which means that the entire estimation process is laden with assumptions. The problems to be addressed in each phase of the estimation process are reviewed in the paragraphs that follow.

Description of the proposed action. An accurate description of the impact stimulus -- the proposed action -- is extremely important to the accuracy of the assessment process. However, impact assessment is generally required well in advance of project implementation and often before detailed work plans are formulated. Thus, the description of the proposed action is frequently based upon preliminary estimates of project scale, work force, local purchases, and implementation policies. Not surprisingly, the character of the action actually implemented usually differs in many important respects from the action proposed. Moore (1979) suggests that it is the forecasts of proposed actions themselves which are the most uncertain component of impact assessment models. Numerous examples support this view. For example, the Jim Bridger power plant near Rock Springs, Wyoming, was originally expected to consist of one unit with a peak construction work force in 1974 of 1,300. In fact, two units were eventually constructed, and the work force peaked at 3,000 workers in 1973 (Susskind and O'Hare, 1977).

Bearing the multitude of uncertainties in mind, what are the key features of the project insofar as economic/demographic estimation is concerned? The analyst is primarily interested in:

- construction work force size, skill composition and schedule
- operating work force size, skill composition and schedule
- wage rates by skill
- project expenditure schedule
- projected amount of local purchases
- any ancillary facilities requirements
- policies toward local hiring
- training programs or other measures adopted to increase the local share of the labor force
- services/facilities to be provided by the developer

These features help to determine the proportion of local employment in the basic work force, the income effects of the project, the tax revenue effects of the project, and the induced employment due to the project.

Local/nonlocal work force composition and residential choice. Once the project work schedule has been provided, it is necessary to estimate the nonlocal portion of the work force, its family accompaniment rate, and its residential distribution among localities within commuting distance to the project site. Empirical data indicates that these parameters vary significantly from project to project. Mountain West Research, for example, surveyed 14 power plant and mining projects (Mountain West Research, Inc., 1975). Nonlocal worker composition of the work force averaged 60.1 percent but varied from 96.8 percent to 21.4 percent among individual projects. Family accompaniment averaged an additional 1.139 persons per nonlocal worker but ranged from 1.869 persons to 0.211 persons per nonlocal worker on individual projects.

One approach is to estimate average relationships using empirical data. Equations incorporating these average relationships are then used in the model to project such things as local share of the work force, age/sex composition of the work force, etc. The allocation of inmigrating workers among several communities has been carried out by ad hoc methods, modified gravity models (Mountain West Research, 1975), and linear programming models. Of course, the problem with any approach based on empirical data is that the number of observations is relatively

small, so that estimated average relationships are not statistically significant. Moreover, each project and site has unique characteristics that render average values inappropriate. Consequently, a great deal of uncertainty attends the prediction of the local labor share, its composition, and the residential distribution of inmigrating workers.

Payroll expenditure effects. Once the work schedule, the local/nonlocal work force composition, and the residential distribution of workers have been estimated, the next step is to estimate income earned and spent by workers. This can be done using anticipated average monthly or annual payroll information furnished by the developer, which is subject to the same errors as the work schedule, although the error may be less serious if average payroll is used. Not all income, of course, is spent, which necessitates an estimate of spendable income. Nonlocal construction workers -- who are temporarily working in a locality away from their home -- are likely to spend less in the locality than local workers. Data on locally spent income is highly limited (Mountain West Research, 1975), thus estimations of local expenditures is often very uncertain.

Economic impact estimation. When the project work schedule, the local/nonlocal composition of the work force, the residential distribution of nonlocal workers, and the income earned and spent by all workers have been estimated, these direct, project-related impacts must be allowed to repercuss throughout the regional economy. There are three techniques that are commonly used to trace impacts on the regional economy: input-output (I-O), econometric, and export base modeling. These techniques are used singly or in combination.

(1) I-O models are usually characterized by a high level of industrial disaggregation, estimated from interindustry transactions data at a point in time and oriented to incremental analysis based on given changes in final demand. They are expensive to construct and suffer from the limitation of representing the structure of the economy at the time of the survey. This is a serious problem since a major consequence of the proposed action may be to change the structure of the local economy and render the interindustry transactions data invalid. Also, input-output models become increasingly less appropriate as the level of industrial interaction in a region falls.

(2) If the comparative advantage of I-O models is their ability to trace the interindustry implications of given changes in final demand, the comparative advantage of econometric models is in determining demand. They have little, if any, industrial disaggregation and the emphasis is on the aggregate level of production, the income induced by it, and on the resulting process of demand generation. The models are typically estimated from a large number of time series observations, and although they can easily be used for impact analysis, they are most often used at the state or multi-county level as a tool to project baseline levels of economic activity. Data required for these models are rarely complete enough for the types of rural counties most likely to experience coal development.

(3) Export base models are less easy to characterize because of the variety of ways in which they can be constructed. Like input-output models, most estimating techniques are based on a point in time; although some techniques, like those suggested by Rosen and Mathur (1974), use time series data. The base model may result in anything from a single total employment to basic employment ratio (multiplier) to a matrix of multipliers specific to each non-basic sector and each basic sector. The export base model is amenable to projecting either levels or incremental impacts and is commonly used in both ways.

Once the direct project-related impacts from development have been determined, the next step in the economic assessment process is to estimate secondary employment change -- increases in employment in industries which sell goods and services directly to coal mining. This step includes a determination of the probability that new coal-linked industries will locate in the region -- and, if so, where and at what levels of employment. This type of secondary economic development may involve a structural change within the regional economy. Neither I-O nor export base models accommodate structural change very well, and thus are not appropriate tools for this step of the analysis. Ideally, an industry location model could be constructed with the key relationships estimated by econometric techniques. However, in practice, the ideal is extremely difficult to realize (see Appendix B), and one is left with strong reliance on "informed judgment." Clearly, the reliability with which secondary employment change can be predicted is an open question.

The economic impact of new employment generated by coal development and new industries directly linked to coal will cause a multiplier effect in the communities where they are located -- increases in the

output of industries which sell goods and services consumed within the local area. If economic base is the approach used, this implies that the split between basic and nonbasic activities be rigorously defined -- something which may present serious difficulties.[1] Tiebout, for example, found that every industry in Los Angeles in 1960 sold a percentage of its output to consumers both within and outside the city's economy (Tiebout, 1962). Fortunately, in the Old West Region, local economies are not nearly so complex as that of Los Angeles, but arbitrary definitions are still unavoidable. A variety of techniques exists to aid in the distribution of basic and nonbasic output in each industry. These range from indirect measurement (through location quotients, for example) to direct measurement (through primary data collection at the industry level). Overall, the uncertainties associated with the basic/nonbasic determination, in a relatively uncomplicated economic setting such as that of the Old West, are not a major obstacle.

One recent improvement in the definition of the basic/nonbasic split concerns the identification of the basic share of income generated in the trade and services sectors. Particularly in the western United States -- where population density is low over a large geographic area -- a clearly delineated trade hierarchy among cities of various sizes has developed. Through established trading relationships, income earned in one locality in a trade area flows, in part, to other, larger communities. The multipliers resulting from these income flows have been quantified at the county level (Chalmers, et al., 1978). Incremental trade flows due to a coal development can be quantified, and the resulting redistribution translated into trade and services employment.

Given the derived estimate of the basic/nonbasic split, the next step of the process is to forecast total employment, with and without the proposed action. The procedure can utilize either income or employment or both, depending upon the type of forecasting method applied. In the more refined methods, basic employment is forecast together with basic income. The latter is used in conjunction with the basic/nonbasic split to produce nonbasic income. Nonbasic income is then converted

[1] This assumes that the economic base approach is the analytic technique used.

into jobs using forecast average wages in the nonbasic sectors. Adding basic employment to nonbasic employment gives total employment.

One final adjustment needs to be made in the employment forecasts: a judgment regarding the degree to which nonbasic employment growth will actually be realized without the proposed action and with the proposed action. The reasoning behind this judgment is discussed in Mountain West Research 1979a, and it underlines the imprecision with which the actual nonbasic employment effects can be determined.

The I-O, econometric or economic base modeling techniques referred to earlier in this subsection can be used to generate the "with and without" forecasts. Each has its advantages and disadvantages. Overall, the economic base approach is the easiest to apply in the OWR economic context. A fourth possible method involves forecasts based upon an eclectic ad hoc approach using secondary data sources and informed judgment. Such a method yields only order-of-magnitude estimates.

The difference in forecast employment, with and without the proposed action, represents the net employment impact due to the action. The reliability of this impact forecast depends upon the accuracy of the description of the proposed action, the quality of the analysis and judgment on which it is based, as well as upon the degree to which unanticipated events take place that significantly influence the final outcome. Overall, forecasts of employment impact have been unreliable, particularly in terms of their distribution between resident and inmigrating workers. Moreover, the levels of uncertainty associated with these forecasts increase rapidly, the further in the future implementation of the proposed action is.

Demographic impacts. The forecast total employment impact must be translated into population impact. This is usually accomplished within a demographic submodel of the overall impact assessment model. The general approach is to forecast future population without the proposed action and then translate the net employment impact of the action into population change through a determination of the nonlocal (inmigrating)

share of the net employment impact, and an assignment of demographic characteristics (including families, age, education, and income) to this nonlocal share.

In estimating the demographic impact, the key question to be answered concerns the degree to which increased employment opportunities will be filled from the local labor market. Thus, an analysis of local labor supply is required. The capacity of the local labor supply to meet new employment opportunities is a function of (1) levels and changes in unemployment rates, (2) changes in labor force participation rates, (3) migration, (4) natural increase (from births and deaths), (5) skill composition, and (6) current wage levels prevailing in the area. As discussed in Appendix B, there are problems associated with the determination of changes in participation rates and unemployment rates. Moreover, much of the migration component is typically treated as a residual, maintaining a balance between labor supply and labor demand. A labor submodel is often incorporated into the assessment model for this purpose.

The migration residual is the most important source of demographic impact. While the composition of the resident population can be forecast by relating present characteristics to employment through cohort survival techniques, inmigrants and their families often exhibit different characteristics. These must be explicitly accounted for in terms of age, sex, education, and labor force participation characteristics.

The final result is usually found in terms of net population increase due to migration and a natural excess of births over deaths. In the short run, the major sources of error in demographic impact assessment result from inaccurate estimates of total employment effects of the action, together with a serious underestimation of the local labor force share of those employment effects. In the longer run, errors in assumptions regarding the total population's vital rates, age/sex distribution, and average household size, can become important.

Facilities/services and land use. The purpose of analyzing the implications of coal development on the availability and cost of public facilities and services is to provide information on the underlying demand for them.

The complexity and cost of community impact assessment procedures currently being used vary enormously. At one extreme, very simple rules of thumb based on average total cost per capita of all public services and facilities are being used. These techniques do not attempt to account for spatial cost variations, the effects of excess capacity, economies or diseconomies of scale, or the effects that rapid fluctuations in demand associated with project construction may have on the cost and availability of public services/facilities and housing. At the other end of the spectrum are the attempts to construct comprehensive housing/land use models which try to deal with all aspects of the spatial distribution of economic and demographic activity. These models have several serious problems. They are extremely expensive, they are very complex, and the key variables on which they are based (e.g., projected land prices and availability) are often not amenable to even reasonably accurate prediction.

There are a number of technical issues regarding the estimation of demand for public facilities and services which will be discussed in more detail in Section 7.1.2.2 below. Suffice it to say that data unavailability typically prevent the analyst from estimating demand precisely.

Conclusions regarding technical difficulties of economic/demographic estimation. While conceptual issues in economic/demographic impact assessment are generally clear, severe data limitations at the local -- substate -- level force the analyst to make a rather large number of assumptions for each step of the estimation process. The necessity for these assumptions prevents the estimation of economic/demographic impacts beyond order-of-magnitude precision. Depending on the validity and the precise nature of the assumptions made, results can vary tremendously.

Results. It is difficult to directly compare the results of complete economic assessments for actual coal development projects, simply because it is difficult to find a case where more than one assessment has been made for the same project. Project work schedules and regions differ enough that a comparison of different projects to judge the volatility of impact assessment techniques is not meaningful. However, a hypothetical example for the same project, using different techniques, has been calculated by Mountain West Research (1979a).

There, a relatively simple example is illustrated. Given annual peak construction and operation work schedules for a hypothetical project, the total population increase associated with each work force is calculated. The estimation procedure involved making assumptions about the local/nonlocal composition of the work force, the family accompaniment rate of nonlocal project workers, the application of the basic/nonbasic multiplier, the calculation of inmigration for nonbasic support jobs, and the family accompaniment rate for nonbasic job inmigrants. Procedures are used which were recommended by Mountain West Research (1979a), the U.S. Department of Housing and Urban Development (1976), and Briscoe, Maphis, Murray, Lamont, Inc.,(1978). The results are presented in Table 7-1. It is assumed that the construction peak force equals 1200 workers and that the operations force equals 130 workers.

TABLE 7-1
Results of Three Economic/Demographic
Techniques for the Same Project

Technique	TOTAL POPULATION INFLUX	
	Construction	Operations
Mountain West	1498	431
H.U.D.	4498	795
Briscoe, et al.	5851	1071

It is striking that the difference between the highest and lowest estimate differs by a factor of four. While neither one nor the other set of assumptions is necessarily wrong, this example illustrates the tremendous variability in results that can derive from different assumptions. In a full-scale economic/demographic assessment, this variability can be accentuated due to the causal flow among steps in the assessment procedure where the results on one step are inputs to the calculations of the next.

7.1.1.2 Economic Development Cycle

An issue that was not addressed above, but which has direct bearing on the total costs associated with coal development is the point in time at which a project enters a locality's economic development cycle. The fiscal situation of state and local government is dependent, in part, on the stage of the economic development cycle. It is also possible for a project to significantly affect local economic development and alter the cycle.

Development economists and economic historians generally accept the broad outlines of a three-stage theory of regional economic development. First, extractive industries develop; second, manufacturing develops; concurrently, services for businesses and households will develop; finally, in a mature economy, services will be the rapid growth sector. During the same time that its economy develops in these stages, a stable hierarchy of cities evolves, each specializing in some aspect of the regional economy. While this outline is oversimplified, the essential point is that a mature economy produces more of the goods and services it needs (and thus becomes less dependent upon the national economy) than does a less developed economy. Most of the Old West Region remains in the first stage of development, with a hierarchy of trade centers servicing a generally extractive and agricultural regional economy.

In this context, a model of economic decline for the local areas hypothesized by Rust and Alonso (1978) is pertinent.[1] Although the

[1] A more detailed discussion is presented in Section B.1.2.1 of Appendix B.

model is hypothetical, it provides a framework for discussing the possible impact of decline upon the fiscal condition of local governments.

1) Initially, the local area has a resource-based economy, and is dependent upon the national economy.

2) A stage of growth occurs which is conducive to future decline. The local resource gains unusual advantage in a national market, accompanied by strong national demand for that resource. Rapid population growth occurs, which accumulates a highly mobile, young, and fertile population.

3) The resource's advantage in the national market passes due to economic factors or exhaustion of the resource. Production of the resource is likely to decline, although perhaps not to its initial level. Therefore, job growth stops (and may, in fact, decline); inmigration ceases.

4) A "shadow boom" occurs, in which migration adjusts the labor force, but population continues to grow due to births.

5) The stage of primary decline occurs. Migrants' children reach working age, seek jobs, are either unemployed or underemployed, or migrate. Rapid outmigration takes place, especially among the skilled, professional, and young.

6) A stage of inelastic decline is reached. Employment falls, but population cannot adjust fast enough because the migrant pool (consisting of the young and skilled) is depleted. A low outmigration rate and chronic unemployment and underemployment (primarily of older workers) results.

7) Finally, a stage of stabilization is reached, but only when the migrant population associated with the original boom ages enough to pass out of the labor force and remove the labor surplus.

The Old West Region has continually experienced boom-bust cycles during its economic history -- gold and silver throughout the region during the 19th century, copper in Montana during the 20th century, and oil and gas in the Williston Basin during the 1950s, to cite a few well-known examples.

In terms of fiscal impact, several observations from the Rust-Alonso model may be made. The period between initial coal development and eventual stabilization, if decline does occur, is lengthy. Stabilization is not reached for a generation, the time it takes for growth-

attracted migrants to completely pass through the labor force. Public revenues and costs are generally not in balance for growing and declining economies. Therefore, it is possible that the fiscal impact on local government due to coal development may be relatively expensive, not only during the initial growth, but for a generation following. The cost of local government may be relatively more expensive in a second sense. Public expenditures in a growing economy are likely to be disproportionately large for infrastructure. If the economy begins to decline without passing through a stabilization stage, the infrastructure will be increasingly overbuilt, but will continue to need maintenance. At the same time, public expenditures in a declining economy with high unemployment and low income levels are likely to be disproportionately large due to income maintenance and social services requirements.

Technical difficulties. The remoteness and resource-based nature of local economies in the Old West Region suggests that the Rust-Alonso model of economic decline has some limited applicability. The Region's economic history reveals a pattern of boom-bust economies. In terms of estimating the fiscal impact of prospective coal development, the Rust-Alonso model strongly suggests that very long-term forecasts -- at least a generation into the future -- should be made. Such forecasts would have to establish whether secondary development -- unrelated to coal development -- occurs; if it does, precipitous economic decline, presumably, can be averted.

These requirements are beyond the current state-of-the-art of economic/demographic forecasting.[1] An alternative to forecasting secondary development is to assume that it will not occur, and to forecast the fiscal impact of decline after an arbitrary period of initial growth. This "bust" forecast can be contrasted to one which assumes constant coal employment (e.g., a stable economy) to derive the fiscal impact of decline.

[1] For reasons why, see Section B.1.2.2 of Appendix B.

Results. No assessment for any project has ever forecast the cost implications of a shutdown of the project. The only empirical evidence which exists is very indirect. Rust and Alonso, using the 1970 U.S. Census, categorized the 133 counties in Montana, North Dakota, and Wyoming by the year in which each county attained its maximum population.[1] The pattern presented by Rust and Alonso is consistent with their hypothesis. Montana, North Dakota, and Wyoming all have economies that are resource-based, but the hypothesized causal relationship has not been empirically estimated.

7.1.2 Fiscal Relationships

Fiscal relationships -- to economic and demographic variables, and among fiscal variables -- are complex, numerous, and unfortunately, often not easily measured in the detail that complete analysis requires nor in the precision that practical usefulness demands.

7.1.2.1 Governmental Interrelationships

As noted in Section 7.1.1.1, in the interest of completeness, all local governments located in the trade area in which resource development occurs should be included in the analysis. However, some public services provided for a given local area are also delivered by state agencies. In addition, local population growth due to coal development will unavoidably generate incremental demands on state government's general administrative services -- from "Fish and Game" to "Revenue and Administration." Table B-2 (in Appendix B) lists typical public services provided to local areas, differentiated by state-delivered services and locally-delivered services.

Since some public services are delivered to a local area by state government, the estimation of fiscal impact is more complicated. This complication extends to the revenue side of the ledger as well. State revenues are importantly affected by coal development and should also be estimated. In addition, these sources of funds affect the volume of state intergovernmental transfers, an important component of local government revenues.

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[1] See Section B.1.2.3 of Appendix B for details.

A reasonable technical approach is to isolate state revenues which are affected by coal-related development, and to forecast them as a function of coal development and other pertinent economic activities. Future levels of economic activity for other variables will have to be projected, assumed, or held constant; a "with" and "without" coal development forecast can then be made. Forecasting intergovernmental transfers presents several problems. The prediction of federal transfers, either to the state or to local governments is exceedingly difficult -- even for order-of-magnitude estimates. Each category of transfer is allocated based on certain formulae, assistance programs are created and terminated, transfers may be based on local assessed valuation that changes dramatically with development, etc. In theory, federal and/or state transfers can be estimated as a function of these variables. However, many intergovernmental transfers are based upon federal or state discretion. This applies, in particular, to transfers for local impact. These types of transfers, subject to all kinds of political and institutional constraints, are virtually impossible to forecast. Based upon local taxes, the intergovernmental transfer requirement can be forecast as a residual (taking total expenditure requirements into account); however, there is no guarantee that funds equaling the residual will be forthcoming.

7.1.2.2 Issues in Estimating Expenditures

A major fiscal impact of coal development can be anticipated to be new public construction, which will be necessary when the capacity of public infrastructure is exceeded by demand. To be able to predict the magnitude of capital expenditures, two pieces of information are necessary: 1) the present capacity of each public facility or system, and 2) the threshold level at which increased population or economic activity will exceed present capacity for each public facility or system.

Present capacity cannot be known without interviewing public officials responsible for each affected facility or system, or by carefully reviewing appropriate public records regarding facility specifications. Estimating threshold levels for new capacity requires a marginal cost approach (Burchell and Listokin, 1978). Marginal costing assumes

a nonlinear relationship between service delivery and demand, while average costing assumes a linear relationship.

Both marginal and average costing are methods to arrive at the per capita public services requirements. Professional standards for public service delivery, of course, also exist, and can be used to project the need for capital expenditures (Burchell and Listokin, 1978; Chalmers and Anderson, 1977; Muller, 1975). An issue, that is not easily resolved, is the applicability of each technique. Marginal and average costing are derivations of the demand curve for public services. In theory, residents of a local area will exhibit their own unique preference for the mix of public services to be delivered. However, the actual delivery of public services is a function of supply as well as demand. Small rural areas are likely to have a tax base which cannot support public services at the level which local demand may ultimately warrant. Other difficulties -- stemming from structural changes -- attend the measurement of demand in smaller localities that will experience substantial growth. For example, residents of such small communities may be accustomed to a rural or small town environment. On the other hand, inmigrants attracted by coal development are often more likely to be accustomed to a more urban lifestyle, and exhibit different demographic characteristics. The type and quality of public services demanded by inmigrants may therefore be different from those demanded by natives. Moreover, temporary inmigrants may have still different services/facilities expectations. Finally, the cost of delivery may vary with population. There is substantial evidence that per capita expenditures change as the level of population served changes (Mountain West Research, 1975; Krutilla, et al., 1976).

7.1.2.3 Specific Fiscal Relationships

Thus far, general concepts and technical limitations have been addressed. This section discusses, in more detail, specific methodologies that are used to calculate local area public services expenditures and revenues.

Public services expenditures

The Fiscal Impact Handbook (Burchell and Listokin, 1978) is a manual, designed for practitioners, which aims to be a standard reference for fiscal analysis. Burchell and Listokin discuss six techniques which can be used to estimate public service costs of local land development.

The per capita multiplier technique assumes that, over the long run, current average operating costs per capita are the best estimates of future operating costs. Expenditures for each public service department are simply divided by population to obtain expenditures per capita. The methodology is simple, but does not yield useful information on optimal capital expenditures timing in rapid-growth situations.

The case study method is a labor-intensive marginal costing technique. Heads of local public service departments are interviewed in detail about current capacity and costs of responding to specific levels of future population. This method assumes that department heads' estimates of standards for public service delivery are the most accurate available. Public service departments may respond to different subpopulations. Local department heads may be able to infer levels of service delivery from knowledge of total population alone; more accurate estimates of required services can be made if department heads are furnished with forecasts of subpopulations. This requires substantial manipulation of the basic population forecasts derived from the economic/demographic model; such manipulation is usually based on derived data, since local data is unavailable.

Burchell and Listokin discuss four other techniques. Of these, three are based on the use of secondary data from the U.S. Census of Governments. Various ratios are computed between local public service delivery -- operating and capital expenses -- and local public service demand -- population. These ratios are cross-tabulated for municipalities by population size group and, sometimes, growth rate. The common assumption among these methodologies is that the demand curve among cities of a given population size and growth rate is identical. This may be a poor assumption when comparing rural boom towns with other

communities across the nation. The sixth technique is the proportional valuation method, in which the ratio of local expenditures to total property value is derived and applied to the value of the development.

Of the six techniques, the per capita multiplier and case study approaches use local data exclusively, and thus are more likely to derive the local demand curve than methods which use comparative data. The per capita multiplier technique is most commonly used in practice, because data are readily available. See, for example, University of Wyoming (1974), U.S. Corps of Engineers (1974), VTN (1974), Woodward-Clyde Consultants (1976), U.S. Bureau of Reclamation (1976), and Krutilla, et al. (1976). The case study approach is preferable over the per capita approach because it directly addresses the problem of estimating capital expenditures. Interviews with local department heads should yield accurate information about present capacity per public service. However, if department heads estimate the level of services required for levels of future population, the danger exists that they will substitute their own demand curve or standards for that (those) of the public.

Revenues. As noted earlier, it is necessary to estimate the impact of development on state as well as local revenues. In principle, coal development can be translated into revenues by: 1) forecasting the appropriate economic variables, affected by coal and secondary development, which are taxed by both state and local governments, 2) applying the appropriate statutory or regulatory formulae to derive revenues from that source, and 3) applying the appropriate statutory or regulatory formulae to state or federal revenues to derive intergovernmental transfers.

In estimating the revenue side of fiscal impacts, intergovernmental transfers pose a particularly difficult problem because they are strongly influenced by policy variables (noted earlier) which are impossible to forecast. A further problem is introduced when taxation or distribution formulae, from which many governmental transfers are derived, include variables that are not specifically forecast as part of the economic/ demographic assessment. Often, the variables forecast in the economic/

demographic analysis can be used as proxies for those required by the taxation or distribution formulae; however, the relationship between them must be inferred.

A number of other variables can affect local revenues. Tax rates can be changed, statutes may be modified affecting the magnitude of intergovernmental transfers, the value of the tax base may change -- a typical effect where rapid growth takes place -- and revenue sources may be altered in a variety of ways in response to development-related problems. Such changes are difficult to forecast. Forecasting accuracy may vary with governmental level, everything else being equal. One recent study found that, in rapid growth situations, county and school district revenues (and expenditure) patterns could be forecast with some confidence, while municipal budgets were likely to vary radically, year by year (University of Wyoming, 1979).

The prediction of revenues, in summary, is made extremely complicated because of the large number of sources, the number of economic/demographic variables on which they are based, and their sensitivity to policy changes. It must also be recognized that the important sources of revenue for any given county, school district or municipality will be limited. The most pragmatic strategy would be to focus the analysis on developing better forecasts or a range of forecasts for these limited sources, avoiding the expenditure of time and budget on the prediction of insignificant revenue sources.

In practice, few revenues are estimated; those which are estimated are aggregated. Property tax valuation and assessed valuation associated directly with the proposed action are often the only revenue component discussed (Bonneville Power Authority, 1977; Tri-County Electric Association, Inc., 1976; Wyoming Coal Gas Co. and Rochelle Co. Gas Co., 1974). In more detailed analyses, property tax revenue derived from other sources -- usually new residential housing -- is also projected (Bichert, Brown, Coddington, and Associates, 1975; University of Wyoming, 1975; Nuclear Regulatory Commission, 1977; Krutilla, et al., 1976; Intermountain Planners/Wirth-Berger Associates, 1974). If the proposed

action is a mine, royalty payments (Krutilla, et al., 1976; Stinson and Voelker, 1978; U.S. Bureau of Indian Affairs, December 1976), and severance taxes (Krutilla, et al., 1976; Stinson and Voelker, 1978) are estimated. Sales taxes -- by direct payroll from the project -- are calculated by many analysts (University of Wyoming, 1975, Ashland Oil and Shell Oil, 1976, and Stinson and Voelker, 1978). Income taxes by workers directly employed from mining have also been considered (Stinson and Voelker, 1978). Income taxes by total employment -- direct and secondary -- caused by mining is estimated by Krutilla, et al. (1976), while Raines, et al. (1978) estimated the total revenues. Only two of the studies reviewed distributed any state revenues to local governments.

Calculation of net fiscal impact. The comparison of public services and revenues impact is straightforward, once appropriate fiscal relationships have been estimated. Projections should be made for two scenarios: "with" and "without" the resource development. The difference between the two scenarios is the impact of development -- that is, the net fiscal impact.

7.1.3 Idealized Fiscal Impact Model

Conceptual issues which were previously discussed -- regarding each step in the entire assessment procedure illustrated in Figure 7-1 -- implied technical solutions. These, taken together, may be considered an idealized fiscal impact model. Contrasting an idealized model with actual approaches to impact assessment, highlights the technical constraints and uncertainties limiting the present state-of-the-art in socioeconomic and fiscal assessment.

7.1.3.1 Scenarios

At least three scenarios should be forecast: a baseline "without development" scenario, a "with development" scenario that assumes resource production for the length of the forecast period, and a "with development" scenario that assumes a decrease in resource production after an initial period of substantial growth. The baseline scenario must be estimated to compare the incremental impacts of the other two scenarios.

7.1.3.2 Economic/Demographic Components

Spatially, the region of interest is the market area in which the coal development project is located. The method used should have the capability of predicting spatial economic/demographic relationships, basic secondary development directly linked to coal, and nonbasic secondary development which is induced by all basic economic activity. The approach should relate economic and demographic growth in a theoretically consistent manner -- a labor supply/demand component in which migration balances labor force. It should also be capable of forecasting detailed subpopulations, and of allocating population by cohort to individual communities.

7.1.3.3 Fiscal Component

All local governments within the market area affected by coal development should be included together with state government services directly delivered to local populations. In order to estimate the timing as well as the magnitude of capital expenditures, marginal expenditures should be calculated and the present capacity of each service should be specified. If possible, unique local demand curves for services should be derived, or professional standards used. Demand for a specific public service can be estimated with more confidence if the client subpopulation is forecast. All local revenues and those state revenues affected by coal and secondary development should be forecast. Like public expenditures, revenues are dependent upon variables which may not be forecast from the economic/demographic model. A reasonable approach is to prioritize revenues by importance, and to forecast either the variables upon which revenues are calculated, or close proxies for those variables.

7.1.4 Examples of Fiscal Impact Analysis

In recent years, a large number of fiscal impact assessments for projects representing several technologies have been carried out in the states of the Old West Region. It is beyond the scope of the present analysis to report detailed descriptions of fiscal assessments in each of these studies. Rather, four studies (Intermountain Planners/Wirth-Berger Associates, 1974; Krutilla, et al., 1976; Stinson and Voelke, 1978; Raines, et al., 1978) have been selected for discussion. Each of

these is relatively recent, each traces the impact resulting from coal development in a locality in the Old West Region, and together they represent a range of conceptual and technical approaches to socioeconomic and fiscal assessment.

7.1.4.1 Overview

Few characteristics of the "ideal" model were ignored by all four of the empirical studies, although no study included all -- or even most -- of its characteristics.

-- No empirical study included the effect on revenues of secondary economic development arising from coal development.

-- No empirical study included estimates of commuting patterns of place of work as opposed to place of residence for inmigrants.

-- No empirical study forecast the impact of a "bust" scenario of local decline.

-- No study forecast fiscal impact in as much detail as recommended by the "ideal" model. No study included all local governments that conceivably could be affected by coal development. Expenditures and revenues by type in the detail recommended earlier were not forecast.

Taken individually, the variation in conceptual and technical approaches among the four studies is substantial. These differences are discussed with respect to scenarios, economic/demographic components, and fiscal components in Appendix B.

Both conceptual and technical approaches for estimating fiscal relationships vary widely across the four studies reviewed here. The wide range of conceptual approaches, the heavy use of proxies to forecast levels of expenditures and (particularly) revenues indirectly attributable to coal development, and the considerable use of ad hoc techniques highlights two major characteristics of fiscal impact assessment. First, the complexity of the local fiscal situation -- the sheer number of revenues and expenditures and the wide range of variables that may affect their magnitudes -- is extremely difficult to conceptualize into a model that can be empirically estimated. Second, the severe data limitations -- ranging from unavailability of actual financial data for smaller

localities to unavailability of data on economic/social variables that might predict expenditures and revenues by type -- forces the analyst to simplify the conceptual and technical approaches and to resort to proxies, ad hoc techniques and simplifying assumptions.

7.1.4.2 Results: A Comparison of the Range of Estimates

Quantitative results produced by different socioeconomic assessments are difficult to compare directly. Projects differ significantly in their scale, location, and operating life. Local economies differ considerably in their complexity, their relative stage of development, their labor markets, and their trading relationships. Local populations may differ in their vital rates and their demand for public services. Local governments in different states differ in the major sources of their revenues. For all these reasons, different projects in different localities at different periods of time can be expected to vary considerably in the magnitude and extent of their impact.

However, socioeconomic and fiscal assessments can be anticipated to produce a wide range of results if different conceptual approaches, techniques, and assumptions are used. The four assessments reviewed here are somewhat comparable, in that each analyzed the effects of coal mining (and, in one case, all energy projects) upon local areas within the Old West Region. However, each study approached the assessment problem using separate assumptions and techniques.

The quantitative results of each of these studies are presented in Table 7-2. The figures of greatest comparative interest are the several standardized ratios. Wide variability is apparent for each ratio -- the results among studies vary from 40 percent to 1800 percent -- illustrating the range of results which can be obtained from different impact studies. It is impossible to isolate the variability in these results which is due to different conceptual and technical approaches, as opposed to that due to different project and local economy characteristics.

TABLE 7-2

Variation in Results [a]
Obtained from Socioeconomic and Fiscal Assessments

Forecast Period	Raines[b]	Krutilla[c]	Intermountain[d]	Stinson[e]
	1975-1985	1975-1990	1975-1990	1976
Project	All coal mines	One 14-mm-ton and four 10-mm-ton coal mines	All energy projects	9.2-mm-ton coal mine
Political Jurisdiction	All local governments in Campbell County, Wyoming	School district and county government, Rosebud County, Montana	All local governments in Campbell County, Wyoming	All local governments in any Montana county
Project Employment	3,586 workers	N.A.[f]	N.A.[f]	213 workers
Total Employment	8,437 workers	3,000 workers	N.A.[f]	N.A.[f]
Population	20,008 persons	9,810 persons	28,300 persons	N.A.[f]
Expenditures	$43.7 million	$90.8 million	$34.3 million	N.A.
Revenues	$56.8 million	$187. million	$29.3 million	$1,259,105
Ratio of Population to Total Employment	2.37 persons	3.27 persons	N.A.[f]	N.A.[f]
Ratio of Expenditures to Population	$2,184	$9,255	$1,212	N.A.[f]
Ratio of Revenues to Population	$2,838	$19,062	$1,035	N.A.[f]
Ratio of Revenues to Project Workers	$14,730	N.A.[f]	N.A.[f]	$5,911

[a] All values represent totals accumulated over the forecast period.

[b] Raines, et al. (1978)

[c] Krutilla, et al. (1976)

[d] Intermountain Planners/Wirth-Berger Assoc. (1974).

[e] Stinson and Voelker (1978).

[f] Not available.

7.1.5 Conclusions

The comparision of existing fiscal impact assessments with the "ideal" model highlights conceptual and technical approaches which are possible, along with operational problems that restrict the present state-of-the-art. These operational problems exist despite significant recent advances in socioeconomic assessment tools and techniques. The variation in results obtained from competent professional studies which use different techniques to overcome these operational problems is great.

The completeness aimed for in the "ideal" model goes well beyond the present state-of-the-art. A complete fiscal impact should encompass all affected local governments -- including those affected by secondary development -- and state government. In terms of analyzing each specific government, this is possible, and is limited only by research resources. However, a complete fiscal impact should also include an analysis of the impact on revenues and expenditures by type. Technical limitations upon this goal are numerous, of which data unavailability with which to measure both financial variables and economic/demographic variables is the most immediate. Also, the complexity of fiscal relationships makes for severe difficulties in attaining completeness. First, a substantial research effort is required, and is not often feasible. Second, important fiscal variables simply cannot be forecast directly or must be forecast in crude, ad hoc ways. The most reasonable approach, given these limitations, is to aim for completeness, but to prioritize detailed variables in terms of their importance to the local situation, the scope desired for the analysis, and the research resources available.

The state-of-the-art in economic/demographic modeling is more advanced. With available resources, all economic/demographic characteristics of the "ideal" model can be estimated. Simplifying assumptions are necessary, and should be clearly stated. All techniques used in modeling economic/demographic relationships could be further defined. In general, the limitations upon economic/demographic modeling appear to be more conceptual than technical. The most severe conceptual limitation appears to be the universal neglect of the fiscal impacts of decline.

Operational problems severely limit the precision with which current state-of-the-art socioeconomic assessments can predict; order-of-magnitude estimates are all that can reasonably be expected. It is tempting, under these circumstances -- given operational constraints which force the analyst to make a long series of assumptions in each step of the socio-economic assessment process -- to use the "worst case" criteria in choosing assumptions. That is, the analyst uses that assumption which generates the greatest adverse impact. In this way, the impact of the "worst case" approach is presented. Such an approach may be recommended in evaluating the coal/energy development decision, but has little utility for realistic planning once the development is inevitable. Order-of-magnitude estimates derived from the most realistic scenarios help immeasurably more in the actual implementation of state and local efforts to deal with project impacts. However, even order-of-magnitude estimates of social overhead costs represent only part of the total costs associated with coal development, as Section 7.2 illustrates.

7.2 Economic Externalities

Effects upon persons not associated with specified purchases or activities are called "externalities" (Davis, 1972). Most of these effects concern so-called common property resources -- resources such as air, surface,and ground water, "wilderness" or other public lands, scenic vistas, and desirable social conditions to which unrestricted access is enjoyed by all who care to use them. The adverse interactions among users of these systems (for example, the worsening of water quality for swimmers due to industrial waste discharge) represent negative externalities or social costs. In economics literature, externalities have commonly been those social costs or spillover effects that have remained largely unquantifiable. In recent years, however, a growing volume of research has been focused on quantifying many of them.

Externalities in the case of coal mining occur when the mining firm does not pay the full costs of its actions; that is, when private costs diverge from social costs. Thus, the total cost to the firm of mining may include the capital and labor charges of extracting the ore, preparing it for shipment, reclaiming the land, state,and local taxes, and tax or royalty payments to the federal government, while the costs of reduced visibility due to fugitive dust, ground water pollution, industrial intrusion, social anomie, and resource depletion may be borne by the public as a whole, with particular incidence on those nearest the site -- local residents. The traditional means of filling the gap between the private and the social costs of mining is through taxation. Often it remains unfilled.

There are three principal questions addressed in this section: (1) what are the negative externalities associated with coal development in the Old West states; (2) to what extent have economists made serious attempts to quantify these externalities; and, (3) what is their likely magnitude? The economic literature on externalities is voluminous,and a detailed review of it is well beyond the scope of

this study.[1] However, in discussing the questions mentioned above, reference to relevant works will be made as necessary.

7.2.1 Types of Externalities

For the purposes of discussion, we have divided externalities of coal mining into two categories:[2] (1) impacts of mining activities on the natural environment, and (2) social costs resulting from mining impacts on the natural and human environments. Many of these externalities have implications for both present and future generations. Regarding the latter -- the social cost implications of present mining activities for future generations -- economic theory has grave difficulties. Time is normally taken into account by economists through application of a social discount rate to the relevant cost and benefit streams of a given action. This discount rate should be largely market-determined and is therefore heavily influenced by the "private time preferences of the present generation of individuals" (Krutilla, 1975). Determining the appropriate social discount rate for the present generation is a subject of continuing debate among economists.[3] Even if a generally accepted method existed for determining the appropriate discount rate, there is no basis for its establishment with respect to generations, yet unborn.

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[1]For examples of relevant literature, the reader should see: Pigou, 1932; Coase, 1960; Mishan, 1971; Lin, 1976; and Rausser, 1974.

[2]Alternatively, one could organize the discussion by specific type of effect (human health, economic productivity of ecosystems, other ecosystem impacts, materials damages, climate, aethetics, visibility, social-psychological, etc.).

[3]The determination of the discount rate is itself a problem. As Krutilla observes:

> there appears to be general agreement that a uniform rate of discount should be applied to all investment opportunities, public and private (with possible adjustment for the treatment of risk) to avoid reallocation of resources from higher to lower yield alternatives. There is less agreement, however, on the question of what should determine this rate much less its precise value (Krutilla, 1975).

A further problem with the social discount rate, even if it could be determined, is that it is likely to change over time. There is no basis upon which such a change could be predicted and taken into account.

Recognizing our inability to develop relevant economic measures for generations whose preferences we cannot survey or analyze, there are two approaches that can be taken to compensate future citizens for the impacts of present resource exploitation decisions:

1) When the exploitation is irreversible and future options are foreclosed, the costs of the activity should be weighted additionally,[1] before the final benefit/cost comparison is made. This additional value is termed the option value.[2] Its effect would obviously be to conserve a greater share of the resource for future exploitation.

2) Trust funds of sufficient magnitude can be established to compensate future generations for the foreclosure of their options on the resource as well as for the negative externalities -- the costs -- imposed on them as a byproduct of resource exploitation. Both Montana and Wyoming have earmarked a share of their coal severance tax revenues for permanent trust fund accounts.

Tax mechanisms, such as the permanent trust fund accounts set up in Montana and Wyoming, have been the most feasible means of effecting intergenerational transfers.[3] This is particularly true under the present conditions of mining in the Old West Region. No mechanism exists for incorporating liability for externalities in the valuation of the resource. Consequently, in the eyes of economists like Krutilla, a severance tax (tied to a trust fund) on the extraction and consumption of the fixed resource stock provides an appropriate mechanism for intertemporal transfers (Krutilla, 1975).

At the same time, mineral fuels taxes are often designed to compensate present generations for the social costs of development (see Section 3.3). Revenues from these sources can provide two forms of compensation to state taxpayers: 1) they can provide budgetary resources to defray the

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[1] Obviously, the "appropriate weight" must be an arbitrary consideration.

[2] This is the value "that arises from retaining an option to a good or service for which future demand is uncertain" (Krutilla, 1975). Krutilla also concedes that the practical application of this consideration is likely.

[3] The ultimate disposition of these trust funds is not specified. Until otherwise disposed of by the respective state legislatures, they exist in perpetuity.

social overhead costs resulting from social and environmental problems which accompany large-scale, rapid mineral resource development and are not otherwise covered by extraction costs; and, 2) they can enable tax relief for state residents by being used as a partial substitute for income, sales, or property taxes. The argument in support of the second point is that the adverse externalities of mineral development fall disproportionately on in-state residents, while the primary benefits of the activity accrue out-of-state, for the most part. As noted earlier, viable methods are lacking to estimate the value of these benefits and their in-state/out-of-state incidence.

Beyond the direct costs discussed in Section 7.1, the types of externalities resulting from coal mining are listed below. The list is meant to be indicative rather than exhaustive. Within each category, a distinction is made between "major" and "minor" externalities. Major externalities are those judged to be common to coal resource development projects and significant from the standpoint of potential costs. A brief assessment of the progress of economic theory in evaluating the costs of major externalities is presented in Section 7.2.2 which follows.

EFFECTS ON THE NATURAL ENVIRONMENT

Major Externalities

1. Loss of Vegetative Cover
   - -- Permanent removal
   - -- Change in species composition
2. Soils Loss (due to erosion and changes in physical properties and/or changes in chemical properties)
3. Increased Air Pollution
   - -- Effects on other living organisms
   - -- Damage to property
4. Surface Water Effects
   - -- Reduced water quality (potential water shortages for other uses such as recreation, irrigation, power generation, etc.)
   - -- Lower water quality (adverse effects on suitability for consumption, recreation, agricultural productivity)
     - changes in suspended solids
     - degradable pollutants
     - non-degradable pollutants
     - persistent pollutants

-- Increased flood potential (as a result of changes in runoff characteristics and drainage patterns)

5. Adverse Effects on Groundwater

-- Aquifer interruption/changes in quantity
-- Lower quality

- degradable pollutants
- non-degradable pollutants
- persistent pollutants

6. Increase in Solid Waste

Minor Externalities[1]

1. Loss of Vegetative Cover

-- Temporary removal

2. Loss of Wildlife Habitat (removal, degradation, change, barrier construction, harassment, predator introduction, or elimination)

3. Surface Water

-- Lower water quality (adverse effects on wildlife habitat and productivity)
-- Water budget (disruption of hydrological cycle)

4. Adverse Geologic Effects

-- Disruption of other mineral deposits
-- Seismic risks

5. Adverse Climatological Effects

IMPACTS ON THE HUMAN ENVIRONMENT

Major Externalities

1. Option Value of Resource Extraction and Consumption

2. Human Health Effects of Air, Water and Solid Waste Pollution Increases

-- Air pollution[2]
-- Water pollution
-- Solid waste pollution

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[1] Under the right conditions, any of these "minor" externalities can become major.

[2] These effects tend to be more serious as a result of emissions due to coal conversion and population growth rather than due to mining itself.

3. Objective Changes with Socioeconomic Effects

   -- Congestion and expansion due to growth

      - time, efficiency, and congestion costs (in public services and facilities)
      - increased incidence of both personal injury and property damage crimes

   -- Adverse economic effects during post-development period
   -- Mental health effects of environmental degradation and increased stress
   -- Inflation of cost of living and land values

4. Scenic-Visual Effects

   -- Visual intrusion (changes in character of landscape)
   -- Reduction in visual distance and clarity

5. Subjective Changes with Socioeconomic Effects

   -- Deleterious alteration of perceived quality of life

      - industrial intrusion
      - community expansion and change
      - change in work environment
      - change in social environment

   -- Social anomie, disorientation, and stress (due to physical, social, and political changes in affected communities)

Minor Externalities

1. Objective Changes with Socioeconomic Effects

   -- Congestion and expansion due to growth

      - increase in travel time and accident rates due to congestion
      - increase in congestion costs of recreation

2. Subjective Changes with Socioeconomic Effects

   -- Psychological costs of changes in the quality of life and social structures
   -- Adverse social/psychological effects during post development period

3. Loss of Archeological and/or Historic Sites

   -- Loss of heritage/knowledge
   -- Loss of cultural opportunity

4. Noise[1]

5. Aesthetic/Scenic-Visual (adverse social-psychological effects of reduced environmental quality

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[1]Noise impacts are highly localized and must be evaluated on a case-by-case basis.

7.2.2 Quantification of Externalities

Economists have long explored theoretical and empirical approaches to the measurement of environmental externalities -- many of which were listed in the preceding section. These efforts have been directed more toward externalities relating to effects on the natural environment than toward effects on the human environment, although a substantial body of research has been developed on the valuation of air pollution effects on health and property values as well as on the valuation of recreation.

For common property resources or public goods, where the absence of market prices is well recognized, damage costs are most often used as demand price indices. However, these damage costs are likely to systematically underestimate total costs since they neglect lost benefits such as the pleasure of stepping outside to get a breath of fresh air or the benefit of feeling secure in one's community (Davidson, 1972). Accordingly, efforts to capture these further costs have focused on the consumer's "willingness to pay" to avoid or reduce them.

There are some references in the literature to the intertemporal problem -- the problem of taking account of future generations' preferences in the measurement of externalities. It is almost uniformly recognized that some allowance needs to be made in the resource development decision-making process for the values and time preferences of future generations. It is also recognized that no methods exist by which the appropriate magnitude of adjustments for intertemporal considerations can be determined. The general conclusion of the analysts is that the validity of such adjustments demands a more conservative weighting of the potential costs of any irreversible decision regarding natural resource exploitation. That is to say that the estimated costs should be increased by some factor.

Bearing the foregoing remarks in mind, we now proceed with a very brief review of the approaches that have been applied or might be applied to measure the major externalities listed in Section 7.2.1. In so doing, any discussion of the theoretical justification for a particular approach is omitted. The detail demanded by such discussion goes far beyond the scope of this report.

7.2.2.1 Major Externalities from Effects on the National Environment

Loss of vegetative cover. The loss of vegetative cover includes both permanent removal and changes in specific composition. Where large areas are concerned, or the loss of vegetative cover has serious implications for soil erosion and depletion of wildlife stock (through habitat loss), the effect can indeed be major.

If the affected vegetative cover concerns directly productive uses such as cultivated crops, natural forage (as on grazing lands) or timber, the value of the loss can be simply estimated to be equivalent to the damages -- in this case, the present value of lost productivity. Obviously, to estimate this loss, future unit prices must be forecast, and the degree to which productivity will be reduced per unit effect on vegetative cover must be known.[1] The approach thus assumes that the total utility of the production foregone is equivalent to the total price that consumers would have paid; that is, market price is a measure of the lost benefits.[2] In many, if not most, cases it can be argued that such an approach underestimates the total damages, since consumer surplus is not taken into account (Davidson, 1972).[3]

When the vegetative cover is not directly linked to products with market-determined prices, a different approach to valuation of the loss is required. One method employed in Louisiana to value effects on wetlands vegetation due to canal construction and bank erosion involved calculating the caloric values of estimated vegetation losses. These

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[1] This physical aspect of impact due to pollution or degradation is known as the dose-damage function. It is most frequently used in connection with air and water pollution.

[2] One strong proponent of this assumption is Dr. Otto Eckstein, who bases his approach to cost-benefit analysis on it. See O. Eckstein, Water Resource Development: The Economics of Project Evaluation, Harvard University Press: Cambridge, 1958.

[3] A further problem where agricultural land is concerned concerns farmers' adaptive responses to the loss of vegetative cover. Different cultivation methods and/or crops may mitigate the effects forecast from the dosage-response factor.

values were then multiplied by an average range of cost/calorie of fossil fuels to obtain a monetary equivalent (Happ et al., 1976). The assumed equivalence in monetary value of a calorie of wetlands vegetation and a calorie of fossil fuels is one glaring weakness of this approach.

Soils loss. The loss of soils, through removal or through changes in physical or chemical properties, due to coal mining or conversion activities, has implications for land productivity and erosion. The latter affects runoff, aquifer recharge, and surface water quality.

Valuation of soils losses is most easily restricted to an examination of damages in terms of lost production (agricultural or grazing land) or lowered recreational value due to destruction of wildlife habitat or aesthetic degradation. The approach one might apply would be similar to that for loss of vegetative cover -- the effects are similar. However, a cursory review of the literature did not identify any studies in which the costs of soil productivity losses due to mining were estimated.

Increased air pollution. Air pollution costs are related to effects on human health, other living organisms, property, and visibility. In terms of coal development in the Old West Region, most pollution effects are associated with conversion activities. However, some fugitive dust effects result from mining, and population growth induced by energy development also has a deleterious effect on air quality. Serious theoretical problems exist in forecasting future patterns and concentrations of air pollution. Noting the existence of these problems, we proceed to the measurement of air pollution effects.

National clean air legislation and environmental concern has sparked a considerable amount of research regarding the costs of pollution. The research has had two primary thrusts of interest here: 1) to quantify the physical effects of pollution on humans, other living organisms, and property, and 2) to estimate the monetary value of those effects. More recently, research has been carried out aimed at valuation of visibility effects. Overall, the annual cost of air pollution in the United States has been estimated at around $20 billion (Freeman, 1979:165).

Air pollution effects on ecological systems and property are discussed below. Effects on human health and scenic-visual values are reviewed later under Section 7.2.2.2.

Air pollution and non-human ecological systems. Air pollution effects on plants and animals have been examined. With respect to agriculture, the costs of pollution have been equated with the present value of estimated production losses. To determine these, the physical effects on productivity must be determined through the establishment of dose-damage functions, relating the presence of pollutants to measurable changes in yield. These functions may describe readily identifiable and quantifiable impacts, but they often neglect more subtle though significant forms of damage. For example, reduced plant vigor, increased susceptibility to pests, and cumulative effects over time are difficult to measure and attribute to a particular cause (Freeman, 1979). Where physical productivity of the land can be maintained by increased costs to combat pollution effects, the decrease in net income is the economic cost to be measured. Effects on silviculture would be treated similarly.

Overall, there remain grave difficulties in determining the economic costs of air pollution effects on vegetation with a market value.[1] Determination of the economic effects on vegetation with no market value or on animal life are beyond the present state-of-the art.

Air pollution effects on property. The adverse effects of air pollution on property have become well documented in recent years. Examples of building deterioration due to air pollution, such as the Taj Mahal, have received extensive coverage in the press. The phenomenon is worldwide. Estimates of the economic costs of property damage are based upon cleaning and repair costs or on property value differentials. In an early study, Michelson and Tourin estimated that such costs averaged

[1] In a 1975 publication, the National Academy of Sciences included a chapter on air pollution effects on agriculture and forestry. However, they noted that an aggregate determination of physical or economic effects is not yet possible (Freeman, 1979).

$84 per capita higher in heavily polluted cities than in relatively unpolluted ones (Michelson and Tourin, 1966).[1] Freeman (1979) presents a review of fifteen studies in eleven cities of the U.S. and Canada that have examined air pollution-property value relationships. Statistical significance of the results was a problem; however, property value declines per unit area were estimated for specified increases in various air pollution factors. It should also be noted that this approach has been restricted to large urban areas. There is as yet little empirical basis for its application in the more rural Old West Region.

Regarding the damages approach (cost of clean-up and repair), one must first determine the probable future pattern and concentration of that pollution as well as the surface area of property exposed to it by type of material, the rates of deterioration per material and the local costs of clean-up and repair. The analyst is called upon to make a number of key assumptions and, since the calculations are sequential, errors or uncertainties in these assumptions are reflected in the final result.

Summary. On balance, the property damage effects will probably dominate the economic costs of air pollution on vegetation, animals and materials. However, estimates of actual damages vary widely, indicative of the uncertainties that permeate the estimation process.

Surface water effects. Major externalities concerning surface water effects include reduced quantity, lowered quality, and increased flood potential due to changes in runoff characteristics.

Reduced quantity. The adverse effects of reduced quantity center on the opportunity costs of the best alternative use of the water or the lost agricultural production due to reduced availability and the loss of recreation benefits due to reduced flow. The first effect can be estimated through valuation of production foregone, while the second is based

[1] See also Lave, L., "Air Pollution Damage" in A. Kneese, ed, Research on Environmental Quality, Baltimore: Johns Hopkins Press, 1971.

upon the valuation of recreation benefits. Two principal approaches to the valuation of recreation benefits are currently utilized: 1) willingness-to-pay and 2) total expenditures. For a review of these techniques see Coomber and Biswas (1972).

The relative importance of lost production and lower recreation benefits depends upon the particular situation being impacted. The accuracy of the production-based estimate depends upon the accuracy of future price and yield forecasts as well as upon the discount rate used. Present methods of attaching an economic value to recreation benefits are rather theoretical and the subject of debate among resource economists. There is some apparent agreement that current valuation methods are able to deal with only a portion of the recreation benefits (Krutilla, 1975).

Lowered quality. The costs imputed to surface water pollution, to the extent that pollution is a possibility under the present regulatory framework, concern consequent adverse effects on human health, treatment costs, aquatic life, property values, and recreation possibilities. These costs and methods of measuring them are reviewed in Kneese and Schultze (1975). The adverse effects on human health,[1] aquatic life (fisheries), and materials (including irrigation and navigation systems and appliances) can theoretically be estimated using the damages approach, treatment costs to maintain existing water quality can be estimated directly, effects on property values can be estimated by regression, and recreation benefits can be evaluated in at least two ways, assuming that the net change in recreation activity levels can be predicted with any certainty.[2] In view of the relatively stringent effluent discharge limitation standards in force in the Old West states, it seems unlikely that adverse water

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[1] "Water pollution may be more costly (than air pollution) in terms of non-human resources, but the current link of water pollution to public health problems on any large scale in advanced countries is a matter of suspicion concerning chronic effects rather than of firm evidence," (Kneese, 1971).

[2] One estimate of the economic costs due to water pollution was roughly $10 billion per year (Heinz et al., 1976).

quality effects will be a significant cost of mineral fuels development compared to the other factors under review, unless large-scale development takes place and standards are not enforced.

Increased flood potential. This effect could occur due to vegetation and land form changes from surface mining and their consequent impact on runoff characteristics. To the extent that flooding occurs and can be attributed to mining or mining-induced impacts (for example, land use changes due to population growth) rather than existing conditions and meteorological phenomena, the damages approach would be used to evaluate costs.

Adverse effects on groundwater. The principal adverse effects on groundwater due to surface coal mining concern aquifer interruption or disturbance drawdown, and groundwater pollution. There are substantial problems in measuring the physical and chemical effects of man's surface activities on groundwater. First, adequate baseline information regarding location, quantity, quality, recharge, etc., is required. Then, monitoring must be carried out and any changes observed attributed to the various probable causes. Once the physical and chemical effects have been identified, both damages and opportunity cost approaches could be used in estimating the minimum economic cost of the externality. To the extent that mining and related activities contribute to the depletion of groundwater in the Old West Region, the consequent economic costs will be extremely difficult to determine. No attempts have been made to evaluate the costs of such an eventuality. In fact, this situation obtains with respect to almost all aspects of groundwater, in general. The costs of adverse externalities have not been estimated.

Increases in solid wastes. Mining and conversion activities related to mineral fuels have important implications for states in the Old West Region. Spoil piles and tailing can be a significant environmental hazard if not handled properly. The sulfur and fly ash resulting from coal-fired power plants represents an important disposal problem. In addition, the population growth associated with increased resource development brings with it many solid waste problems. The external diseconomies resulting from these solid wastes are found primarily in their

impact on the human environment -- through effects on health, productivity, and aesthetic values (visual intrusion impacts). The potential also exists for adverse effects on other ecological systems through contamination of soil, groundwater, and wildlife resources. The dose-damage function for such effects in the OWR remain to be determined. Their economic costs remain indeterminant.

7.2.2.2 Major Externalities Related to Impacts on the Human Environment

Among all of the negative externalities under review in this section, those relating specifically to the human environment have received the least attention from economists. At the same time, in absolute cost terms, these externalities may be the most important of all. There are formidable conceptual problems to be overcome in attaching meaningful costs to social effects.[1] Some attempts have been made to define objective measures of the "quality-of-life" and estimate economic values for changes in those measures. Unfortunately, these attempts must inevitably assume economic reasons for differences in quality-of-life measures. The empirical bases for the assumed relationships are inconclusive.

Option value of resource extraction and consumption. The option value of resource extraction and consumption is the value "...that arises from retaining an option to a good or service for which future demand is uncertain" (Krutilla, 1975). Krutilla argues that such a cost should be considered in the cost-benefit analysis of irreversible resource exploitation decisions. While the option value is a cost of future extraction and consumption opportunities foreclosed, and thus must logically have some order of magnitude relationship to the total value of mineral output, no method has been conceived for quantifying it. We can say intuitively that the option value of Old West coal extraction must be large, but we are unable to estimate how large it might be.

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[1] For a detailed discussion of the types of social impact that might take place as well as of methods for evaluating social impact, see Abt Associates, Inc. Social Assessment Manual: A Guide to the Preparation of the Social Well-Being Account, Cambridge, 1976; and Finsterbusch, Kurt. "A General Conceptual Framework for Assessing Social Impacts of Projects and Policies on Communities." Social Impact Assessment, No. 27, March 1978.

Human health effects of increases in air, water and solid waste pollution. Some of the effects of air pollution on human health are definte and measurable,

> ...but most are ill-defined and difficult to measure, even conceptually. Thus, scientists still disagree on the quantitative effect of pollution on animals, plants, and materials. Some estimates of the cost of the soiling and deterioration of property have been made, but the estimates are only a step beyond guesses. We conjecture that the major benefit of pollution abatement will be found in a general increase in human happiness or improvement in the quality of life, rather than in one of the specific, more easily measurable categories (Lave and Seskin, 1972).

The approach followed is to first determine the increase in morbidity for specific diseases that can be ascribed to increases in the levels of particular air pollution parameters. To accomplish this, dose-damage functions must be established for the various pollution parameters and the health problems to which they contribute. The relationship between air pollution and health is reasonably well established for some diseases (particularly, cardio-pulmonary diseases) and not at all for others. In any case, once the changes in morbidity and mortality have been determined, they are then valued in terms of "direct costs" (medical expenses and burial costs) plus earnings foregone to arrive at an overall "economic" cost of pollutions effect on health -- this is what society would theoretically be willing to pay to lessen the pain, and prevent the disability and premature death which would otherwise result from the increased pollution.

For the nation as a whole, Lave and Seskin estimated the 1970 costs of air pollution's effect on human health at $2 billion. However, as they stated, "...these dollar figures are surely underestimates of the relevant costs.... It seems evident that the value used for foregone earnings is a gross underestimate of the actual amount" (Lave and Seskin, 1972). For comparison, another study estimated the total damages to human health related to air pollution at $5.7 billion per year (U.S. Environmental Protection Agency, 1974). The reasons that many analysts like Lave and Seskin feel the health costs of air pollution are underestimated are that direct and indirect costs due to other diseases have been ommitted and, perhaps more importantly, that earnings foregone

are not representative of the amount that society is willing to pay to reduce morbidity and mortality.[1] With respect to the latter factor -- mortality -- a popular approach is based upon empirical estimates of the willingness to pay to prevent death. The results are expressed as the value of a statistical life (see Freeman, 1979: Chapter 7). The wide range of the estimated value of a statistical life -- from $28,000 (Jones-Lee, 1976) to $200,000 (Thaler and Rosen, 1976) -- illustrates the problems in establishing economic costs for health effects with any confidence.

Water pollution and human health. The determination of the effects of water pollution on human health follows the approach outlined under air pollution effects, above. However, the dose-damage functions for water quality parameters have thus far eluded any meaningful quantification. In one recent study, the health effects of water pollution were not considered a dominant factor in overall water pollution costs, accounting for about $0.6 billion per year (Heinz et al., 1976).

Solid waste and human health. Except for particular toxic substances, the health effects of solid wastes remain difficult to document. If dose-damage functions could be determined, then techniques similar to those applied to air pollution effects might be used to calculate order of magnitude, lower bound costs.

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[1] Relevant sources dealing with these issues include Lane, L., and E. Seskin, Air Pollution and Human Health, the Johns Hopkins University Press: Baltimore, 1977; and Ridker, R., Economic Costs of Air Pollution, Praeger Publishers: New York, 1967. John Gregor expanded on the earnings foregone approach in estimating the value of reduced health risks from air quality improvements in the Pittsburgh area. He extrapolated from data on the higher compensation demanded by workers on jobs with higher injury and death rates. Gregor, J., "Intra-Urban Mortality and Air Quality: An Economic Analysis of the Costs of Pollution Induced Mortality," Center for the Study of Policy, Pennsylvania State University, 1977. Professor Thomas Power drew on Gregor's work to estimate the per capita value ($221) of Montana's lower (than national average) levels of particulate and SO_2 emissions. Power, T., "The Economic Value of the Quality of Life in Montana: A Preliminary Reconnaissance," University of Montana: Missoula, 1978.

Summary. In terms of effects on human health, air pollution effects appear at present to constitute the most well researched area, as well as the source of dominant external costs. Nevertheless, the extension of (still unsatisfactory) valuation methods discussed in the Old West mineral fuels case is not feasible at the present time -- the empirical bases for that extension largely remain to be established. For water and solid waste related externalities, the possibility of meaningful quantification seems even more remote.

Objective changes in the human environment with socioeconomic effects. Objective changes in the human enviornment relate to changes in socioeconomic attributes that are measurable via statistical indices. Crime rates, income levels, housing condition, and incidence of alcoholism are examples of objective measures. The problem with these measures is that, although they are useful in determining what has happened, social scientists have been unable to reliably forecast their future levels due to a specific change or set of changes. There are too many exogenous factors important to their determination.

Our inability to forecast future socioeconomic conditions is relevant to the work which has been carried out on the value of differences in quality of life (QOL). In general, QOL is thought to vary inversely with population growth, particularly with respect to urban population growth. Wingo defines the quality of life as the quality of the social and physical (both human-made and natural) environment in which people pursue the gratification of their wants and needs (Wingo, 1973)[1]. A variety of definitions of quality of life have been developed. Power (1978) summarizes several of them with respect to Montana's standing compared to other states. Rankings ranged widely for specific quality of life indicators (from 5th in agriculture to 47th in technological change) and did not agree on Montana's overall quality of life rating.

[1] Social scientists generally distinguish between QOL, which relates primarily to effects at the individual or household level, and social well-being, as used by Abt (1976), which includes QOL indices, but also examines effects in the community, regional or even national contexts. In many cases, both concepts are used interchangeably.

Since analysts disagree about what comprises QOL and how to measure it using historical values, there is no well-grounded base from which to attempt to predict future values. Moreover, many of the components of QOL are never used for predictive purposes. Thus, at present, QOL cannot be forecast, neither can the economic value of possible future changes in it.

Congestion and expansion due to growth. Population growth due to resource development brings with it a number of mixed blessings. First, due to inadequate public services and facilities during the initial stages of growth, congestion costs -- inefficiencies due to mutual interference among units using a common facility are generated. The interference can be physical as with vehicles on a highway or it can take the form of adverse psychological effects as with the sighting of other persons reducing the perceived value of a wilderness experience. Regarding physical congestion, its costs can be evaluated in terms of the additional time required by citizens to obtain public services.[1] However, with respect to education, congestion (overcrowding) costs are much more difficult to establish. Congestion effects on the quality of education are virtually impossible to determine since measurement of the quality itself is open to question.

With respect to psychological congestion effects, these have been evaluated in a variety of recreational settings. The approach used values congestion costs in terms of a reduction in willingness to pay for use of a facility (Howe, 1979).[2]

In addition, congestion effects due to growth mean reduced quality for a variety of public services and facilities such as public safety, general administration (including permitting), sanitation, public transportation, and public health.

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[1] This approach is a variation of that applied to the determination of congestion costs in traffic engineering cost-benefit analysis.

[2] For a more detailed discussion of congestion in outdoor recreation, see Fisher and Krutilla, 1972.

In the west, rapid growth has often been accompanied by an increase in crimes against individuals and property. The costs of increased crime are:

1) Increased law enforcement costs
2) Increased criminal justice costs
3) Bodily injury and property damage costs (including higher insurance payments),
4) Increased costs for personal security (double locks, alarm systems, etc.),
5) Psychic costs, and
6) Lost revenues due to lower utilization of public places.

Except for 5 and 6, an order-of-magnitude estimate of these costs can be made from available data sources.

Adverse economic effects during post-development period. Montana cities and towns are generally familiar with the boom/bust cycle. As pointed out in Section 7.1, bust cycle direct costs are never taken into account in impact analyses. The same can be said for the economic costs of the post development period. The quantification of these costs presents many theoretical and practical problems that remain unresolved at present. First, there is the purely speculative nature of any extimate regarding the timing and degree of the bust cycle. Second, what are the costs of bust and to what extent can an appropriate share of them be allocated to coal extraction and related industries? There is no answer to the first problem -- economists have a poor record of forecasting major economic events in the near term, much less the long term. Regarding the second issue, there are at least two alternatives one might consider:

1) Estimate the replacement cost of the extraction-based activities by industrial activities typical of a more mature economy; and,

2) Estimate the amount society would be willing to pay to encourage the diversification of the OWR industrial base.[1]

[1] In effect, one of the arguments made for a mineral fuels severance tax is that it provides resources which can be used to broaden a state's industrial base and thus render it less susceptible to economic disaster, once the mineral fuel resource is exhausted.

Neither of these approaches would address the full economic costs and only the first approach would be made operational with existing data sources, and a reliance on heroic assumption.

Mental health effects of environmental degradation and increased stress. To the potential health effects of environmental degradation discussed previously must be added the mental health effects induced by environmental degradation and growth. These include increased incidence of drug abuse, alcoholism, and mental illness. In a manner similar to other health effects, if the relationship between mental health problems and coal resource development activities would be quantified, then a direct costs plus income foregone approach could be taken to develop a partial estimate of the economic costs already incurred in western coal areas. To our knowledge, no such estimates have been made. In view of this situation, economists' ability to meaningfully forecast such costs must be rated very low.

Inflation of cost of living and land values. There is an assumed relationship between energy resource development activities and cost of living increases in communities such as Rock Springs or Gillette, Wyoming, and Mercer County, North Dakota. Housing and land costs are thought to be particularly sensitive to development pressures. No estimates have been made of the "economic cost" of this inflation.

Scenic-visual and other aesthetic effects. Scenic-visual effects include visual intrusion or changes in the character of the landscape and visibility impacts or reductions in visual distance and clarity. Efforts to quantify the costs or benefits of reduction (improvement) in scenic-visual parameters have most recently relied on willingness to pay techniques used commonly to evaluate recreation resources.

Visibility effects. Since air pollution results in reduced visibility, serious efforts have recently been made to attach a cost to this effect. The approach used has employed bidding game techniques to construct aggregate demand curves and estimate consumer surpluses reflecting aesthetic preferences for public goods such as unimpaired visibility (versus an impaired alternative), no adverse visual intrusion, and "wilderness" experience. In this approach, individual consumers of the public good are interviewed on how much they would be willing to pay to prevent a given situation from occurring, thus preserving the existing situation.[1] Often, the problem is posed in the form of an entry fee to a park or campground where the desired situation would either be preserved or restored. The specific nature of the procedure is described in Randall,et al., 1974 and Brookshire,et al., 1976. In the latter work, recreators were surveyed at Lake Powell in the Glen Canyon National Recreation Area regarding how large a daily fee per family they would be willing to pay to prevent the visual intrusion and reduced visibility due to air pollution from a power plant near the lake. Those interviewed indicated that they were willing to pay an average $2.77 to avoid the plant-related effects.

The approach is important because of its attractiveness for imputing values to a variety of public good externalities to which more direct methods such as "damages" are inapplicable. Leaving aside the problems with the consumer surplus approach, the underlying assumptions are that the bidding game can be controlled for biased or strategic responses, that the results represent a valid measure of welfare changes if both income effects and the effect itself are relatively small (Brookshire et al., 1976), and that the bids offered do not differ significantly from what bidders would really be willing to pay. While there is some disagreement on the first two points, it is the last assumption which is the most questionable.

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[1] Alternatively, individuals can be asked how much they would demand to be paid to allow a given adverse action to take place.

Bohm (1972), in evaluating willingness to pay to see video tapes of television programs, found some evidence of strategic bidding, depending upon how the game was presented, but his results were inconclusive. In fact, in most circumstances, the hypothetical payment approach to costing aesthetic damages is quite different from the way most individuals think about the problem. When the bidding game is hypothetical, and no payment actually has to be made, how well are individuals likely to be able to value a public good like clear visibility? Moreover, once people have experienced reduced visibility for some time, the amount they would be willing to pay may change. Also, having paid a given sum for a period of time, their valuation of the externality may change. The problem is one of accuracy: how accurately can an individual determine his preferences in a hypothetical situation and what are the incentives or demands for accuracy? The accuracy issue has been almost totally ignored in the economics literature, and there is virtually no empirical evidence regarding the magnitude of the problem (Freeman, 1979:98).

Visual intrusion. Visual intrusion was mentioned in passing under air pollution effects. It has been evaluated using the same approach as for reduced visibility; i.e., willingness-to-pay as determined from bidding games. However, there are many types and degrees of visual intrusion. The comparative importance of particular source of visual intrusion must be assessed before costing can be carried out. This assessment must be based upon the aesthetic qualities of the landscape in which the intrusion takes place.[1]

Other aesthetic effects. The external costs with respect to other aesthetic effects of mineral fuels development are partially captured in the reduction of recreation benefits. Reduced recreation benefits are

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[1] Several formal approaches to landscape classification and visual impact determination have been developed in recent years. See, for example, Litton, R., "Appraising the Dimensions of the Landscape", and Crak, K., "Appraising the Objectivity of Landscape Dimensions," in Krutilla, J., ed, Natural Environments: Studies in Theoretical and Applied Analysis, Johns Hopkins University Press: Baltimore, 1972; U.S. Department of the Interior, Bureau of Land Management, Visual Resource Management, Manual 8400, Washington, D.C., 1978.

considered by one economist to be the single most important effect of water pollution (Freeman, 1979). However, they also result from air and solid waste pollution, congestion in recreation areas (including wilderness), and adverse impacts on vegetation and wildlife. The willingness-to-pay approach has been extensively used to evaluate recreation impacts. In more developed areas, property value analysis has also been used in an effort to quantify impacts on public and private recreational land or adjacent property.

Subjective changes with socioeconomic effects. Externalities associated with subjective changes in the human environment are those perceived to occur by individuals themselves. From the individual's point of view, changes in statistical indices of the quality of life are not nearly as relevant as how he or she perceives the quality of life to have changed. Moreover, there is a whole category of social-psychological effects for which no objective measures exist. Attaching costs to perceived adverse changes in the quality of life or to social anomie, disorientation and stress is not possible. One might consider attempting their valuation through an approach based on how much people would be willing to pay to avoid them. However, such an approach seems entirely unsatisfactory given the non-economic variables involved. We would maintain that any meaningful definition and estimate of the "costs" associated with the subjective effects of resource development is impossible.

7.2.3 Summary

This section has been concerned with the problems associated in estimating the true costs of economic externalities -- past, present, and future. It is noteworthy that even in areas of intense investigation, such as the health effects of air pollution, senior analysts remain skeptical regarding how much of the adverse effects are amenable to cost determination, and how accurate those determinations are likely to be. Moreover, significant cost categories (option values, adverse economic effects of post development, and subjective changes in the quality of life) resist quantification. All of these costs are borne disproportionately by the region's residents.

While the preceding pages have recited the litany of adverse impacts and negative externalities, there are important positive externalities as well. Reduced unemployment, increased income and, in some cases, an expanded range and quality of public services could represent significant external economies. Of course, many of these benefits will accrue to persons from outside the region. Nevertheless, a complete evaluation of externalities resulting from coal mining should compare the positive with the negative effects. Unfortunately, because of the inability to quantify many of the most important externalities, such a comparison cannot be made.

7.3 Relationship of Direct Costs to Total Costs

The preceding sections of this chapter have discussed the state of the art in quantifying the social overhead costs and externalities associated with coal development. Regarding social overhead costs, it has been shown that substantial conceptual and technical difficulties remain to be solved in accurately estimating the fiscal implications of a particular development for state and local governmental jurisdictions. However, one can take the conservative approach to quantifying these implications by assuming the worst case in every incidence. While this

is not necessarily helpful for local budgetary planning and decision making, its use would establish the highest possible burden of direct cost responsibilities that might be imposed on the governmental entities involved. However, the meaningful estimation of the larger share of economic externalities or social costs associated with coal development has been shown to be impossible, given present techniques. Overall, the magnitude of the externalities may dominate direct costs. The option value of the depleted resources together with the long-term social costs of industrial intrusion alone are likely to be extremely large. This is a sobering thought, for it implies that the historical bases for public resource development decision-making processes have not and could not have account of major -- perhaps dominant -- considerations.

The conclusion that an important share of the costs associated with coal resource development cannot be determined with any confidence -- if at all -- renders benefit criteria impractical as the basis for establishing appropriate levels of mineral fuels taxation. We are left with the ability to pay criterion. On this basis it is clear that Old West states have several specific purposes in mind when levying mineral fuels taxes. These purposes are very much related to the internalization of social costs and intergenerational transfer (see Chapter 3) and include:

1) Provision of revenues adequate to cover the net direct costs imposed on state and local jurisdictions as a result of resource development;

2) Compensation of future generations, in-state, for the value of resource extraction and consumption options foregone; and

3) Compensation of present and future generations for the negative externalities incurred, in-state, as a result of resource development.

In addition, certain Old West states have made no secret of their expectation that mineral fuels tax burdens will be exported to other states. As we saw in Chapter 6, those taxes are largely exported, although to no greater extent than many other types of taxes imposed by other states.

BIBLIOGRAPHY

BIBLIOGRAPHY

Economic/Demographic and Fiscal Impact Analysis

Ashland Oil, Inc. and Shell Oil Co.
1976 Oil Shale Tract C-b, Socio-Economic Assessment, C-b Shale Oil Project. March.

Beckhlem, T.L.; Chalmers, J.A.; and Hannigan,W.M.
1975 Atom 3, Final Report to the Four Corners Regional Commission and the Office of Regional Economic Coordination, U.S. Department of Commerce. Phoenix, Arizona: Arizona Office of Economic Planning and Development.

Bickert, Brown, Coddington, and Associates.
1975 An Analysis of the Jim Bridger 4 Impacts -- Social, Economic, Public Sector. October.

Bonneville Power Authority
1977 BPA Electrical Service to the Northwest Alloys Magnesium Plant, Draft Enviornmental Impact Statement. February.

Borchert, John R., and Adams, Russell B.
1963 Trade Centers and Trade Areas of the Upper Midwest. Urban Report No. 3, Upper Midwest Economic Study. Minneapolis. September.

Bowen, W., and Fibegan, K.
1969 The Economics of Labor Force Participation. Princeton, New Jersey: Princeton University Press.

Briscoe, Maphis, Murray, Lamont, Inc.
1978 Action Handbook for Communities Facing Rapid Growth, Vol. 1. For U.S. Department of Environmental Protection. Denver, Colorado.

Burchell, Robert W., and Lestokin, David.
1978 The Fiscal Impact Handbook. New Brunswick, New Jersey: The Center for Urban Policy Research.

Chalmers, James A., and Anderson, Eric J.
1977 Economic/Demographic Assessment Manual. For Bureau of Reclamation, U.S. Department of Interior. Denver, Colorado. November.

Chalmers, James A., et al.
1978 "Spatial Interaction in Sparsely Populated Regions: An Hierarchical Economic Base Approach. International Regional Science Review. Fall, Vol. 3, No. 1.

Dernberg, T. and Strand, K.
1964 "Cyclical Variation in Civilian Labor Force Participation." Review of Economics and Statistics. Vol. 46:378-391. November.

DeVeny, George R.
n.d. "Construction Employee Monitoring: The TVA Experience, 1968-1976." Knoxville, Teen.: Tennessee Valley Authority.

Goldner, W., et al.
1972 Projective Land Use Model. 3 Vols. Berkeley, California: Institute of Transportation and Traffic Engineering, University of California.

Greenwood, M.R.
1975 "Research in Internal Migration in the United States, A Survey." Journal of Economic Literature. June.

Happ, G. et al.
1976 Impacts of Outer Continental Shelf Activities: LaFourche Parish, LA. Baton Rouge, LA: Louisiana State University, Center for Weland Resources. August.

Harris, Curtis C.
1973 The Urban Economics, 1985: A Multi-Regional Multi-Industry Forecasting Model. Lexington, Mass.: Lexington Books.

Intermountain Planners, and Wirth-Berger Associates.
1974 Capital Facilities Study: Powder River Basin. For Wyoming Department of Economic Planning and Development. April 1.

Johnston, J.
1972 Econometric Methods. New York: McGraw-Hill.

Kingston, J., and Burgess, P.
1976 "Labor Force Participation and Industrial Structure: A Cross-Sectional Analysis." Phoenix, Arizona: Arizona Office of Economic Planning and Development. May.

Krutilla, John V.; Fisher, Anthony C.; and Rice, Richard E.
1976 The Regional Economic and Fiscal Impacts of Energy Resource Development: A Case Study of Northern Great Plains Coal. Revised draft. Washington, D.C.: Resources for the Future, Inc. August.

Leholm, Arlen F.; Leistritiz, Larry; and Wieland, James S.
1975 Profile of North Dakota's Coal Mine and Electric Power Work Force. North Dakota Agricultural Experiement Station. Agricultural Economic Report, No. 100. August.

Lowry, I.S.
1964 A Model of a Metropolis. RM-4035-RC. Santa Monica, California: The Rand Corporation.

Mather, V.K., and Rosen, H.S.
1972 "An Econometric Expert Base Model: A New Technique." London Papers in Regional Science, 3.

Mazeh, W.F.
1969 "Unemployment and the Efficiency of Migration." Journal of Regional Science. April.

Moore, Keith D.
1979 Simulating Energy-Related Growth: Models, Uncertainty, and the Local Response. Denver, Colorado: Denver Research Institute.

Mountain West Research, Inc.
1975 Environmental Baseline Studies for Crow Indian Coal Leases, Soci-Economic Report. Prepared for Westmoreland Resources. Billings, Montana.

1976 Construction Worker Profile: Final Report. Prepared for Old West Regional Commission. Billings, Montana.

1979 A Guide to Methods for Impact Assessment of Western Coal/Energy Development. Prepared for the Western Coal Planning Assistance Project. Billings, Montana.

Muller, T.
1975 Fiscal Impacts of Land Development. Washington, D.C.: Urban Land Institute.

Muth, R.
1971 "Migration: Chicken or Egg?" Southern Economic Journal January.

National Association of Counties
1976 "No. 4. Nuclear Power Plant Development, Boom or Boon? County Experiences." Case Studies in Energy Impacts. Washington, D.C. July.

Nuclear Regulatory Commission
1977 Bear Creek Project, Draft Environmental Impact Statement. January.

Purdy, B.J., et al.
1977 A Post Licensing Study of Community Effects at Two Operating Nuclear Power Plants: Final Report. Oak Ridge National Laboratory. September.

Raines, John A.; VanderMuelen, Allen; and Griffin, Kenyen N.
1978 Assessment of Public Revenues and Expenditures Attributable to the Coal Industry in Wyoming. Summary Report. Laramie, Wyoming: Institute for Policy Research. March.

Renand, B. and Pham, Dic-Tu.
1975 "Regional Labor Force Participation and the Discouraged Worker Hupothesis: Some Empirical Evidence." Annals of Regional Science. Vol. 9:9-20. November.

Rust, Edgar, and Alonso, William.
1978 Adaption or Reversal: Policies for Quality of Life in the Economically Declining Parts of Montana, North Dakota, and Wyoming. Prepared for the Old West Regional Commission. Berkeley, California: Berkeley Planning Associates.

Susskind, Lawrence, and O'Hare, Michael.
1977 Managing the Social and Economic Impacts of Energy Development. Cambridge, Mass.: Massachusetts Institute of Technology.

Thompson, Wilbur R.
1969 "The Economic Base of Urban Problems. Contemporary Economics Issues. Richard D. Irwin (ed.).

Tiebont, Charles M.
1962 The Community Economic Base Study. New York: Committee for Economic Development.

Tri-County Electrical Association, Inc.
1976 Wyodak to Antelope 230KV Transmission Line, Applicants Environmental Analysis. February.

U.S. Bureau of Indian Affairs
1976a Crow Ceded Area Coal Lease, Tracts II and III, Westmoreland Resources, Final Environmental Statement. December.

1976b Navajo-Exxon Uranium Development.

U.S. Department of Housing and Urban Development
1976 Rapid Growth from Energy Projects. Washington, D.C.

Weiland, T.S.; Leistritiz, F.L.; and Murdock, S.H.
1977 "Regional Operating Worker Profile: North Dakota, Montana, and Wyoming." Fargo, North Dakota: North Dakota State University.

Woerner, John R.
1975 Central Places of Southeastern Montana. Unpublished master's thesis. Missoula: University of Montana.

Wyoming Coal Gas Co. and Rochelle Coal Co.
1974 Environmental Assessment for a Proposed Coal Gasification Project. October.

Wyoming Department of Administration and Fiscal Control, Division of Research and Statistics.
1978 Wyoming Population and Employment Forecast Report. Cheyenne, Wyoming.

General Public Finance

Boulding, K.E.
1945 "The Concept of Economic Surplus." American Economic Review, December.

Musgrave, Richard A., and Musgrave, Peggy B.
1976 Public Finance in Theory and Practice. New York: McGraw Hill.

Peckman, Joseph H., and Okner, Benjamin A.
1974 Who Bears the Tax Burden. Washington, D.C.: The Brookings Institute.

History and Description

Boyle, Gerald
1976 Coal Industry in New Mexico. Albuquerque, NM: The University of New Mexico, New Mexico Energy Institute.

Council of State Governments
1976 Coal: State Coal Severance Taxes and Distribution of Revenue. Lexington.

Lockner, Allyn O.
1965 "The Economic Effects of the Severance Tax on Decisions of the Mining Firm." Natural Resources Journal, Vol. 4, No. 4. January.

Roberts, Warren A.
1944 State Taxation of Metallic Deposits. Cambridge, Mass.: Howard University Press.

Stinson, Thomas F.
1978 State Taxation of Mineral Deposits and Production. Washington, D.C.: U.S. Department of Agricultural and Applied Economics. September.

Stinson, Thomas F., and Voelker, Stanley W.
1978 Coal Development in the Northern Great Plains: The Impact on Revenues of State and Local Governments. Washington, D.C.: U.S. Department of Agriculture, Economics, Statistics and Cooperative Service.

Thompson, Layton
1977 The Taxation and Revenue System of State and Local Government in Montana as of 1976. Department of Agricultural Economics, Montana State University. Staff Paper 77-12. June.

1978 "The Taxation and Revenue System of State and Local Government in Montana." Montana Agricultural Experiment Station, Bulletin 701. March.

Tippit, John A., et al.
1960 "Ad Valorem and Production Taxation of Mining Properties." In American Law of Mining, edited by the Rocky Mountain Mineral Law Foundation. New York: Mathew Bender and Company, Inc., Vol. 4.

University of Arizona, College of Mines.
1969 Symposium on Mine Taxation.

Mineral Fuels Supply and Demand

Abt Associates.
1979 Forecasts for Western Coal/Energy Development. Prepared for the Western Coal Planning Assistance Project. Billings, Montana.

Atkinson, Scott E., and Halvorsen, Robert.
1976 "Demand for Fossil Fuels by Electric Utilities." Econometric Dimensions of Energy Supply and Demand. A.B. Askin and J. Kraft (eds.) Lexington.

The Billings Gazette.
1979 "Selling the Synthetic Solution." August 5.

Charles Rivers Associates
1977 Coal Price Formation. Palo Alto.

Darnstadler, J.; Dunkerley, J.; and Alterman, J.
1977 How Industrial Societies Use Energy. Baltimore, Maryland.

Edey, Anthony: Kennedy, Bruce; and Readdy, Leigh.
1978 Oil Mining: Technical and Economic Feasibility Study of Oil Production by Mining Methods. For U.S. Bureau of Mines. Kirkland, Washington.

Electric Power Research Institute
1977 Supply '77.

Energy Development Consultants, Inc.
1978 Mining for Petroleum Feasibility Study. Golden, Colorado.

Gordon, Richard L.
1976 Coal and the U.S. Electric Power Industry. Baltimore: Johns Hopkins University Press.

Lieberman, M.A.
1976 "United States Uranium Resources -- An Analysis of Historical Data." Science. Vol. 192, No. 4238:431-6. April.

Mountain West Research, Inc.
1979 Fact Book for Western Coal/Energy Development. Prepared for the Western Coal Planning Assistance Project. Billings, Montana.

National Petroleum Council, Committee on U.S. Energy Outlook.
1972 U.S. Energy Outlook. December.

Quality Development Associates
1979 The Wyoming Uranium Industry. Cheyenne, Wyoming: Wyoming Department of Economic Planning and Development.

U.S. Department of Energy
1979a "Cost and Quality of Fuels for Electric Utility Plants." (Monthly report). Washington, D.C.: Energy Data Reports. April 1978 and April 1979.

1979b Interim Updates to 1985 and 1990 Regional Forecasts. April.

U.S. Department of Interior, Bureau of Mines
1975 Minerals Yearbook, Vol. 1, 2. U.S. Government Printing Office.

1978 Minerals in the Economy of Montana. U.S. Government Printing Office.

U.S. Energy Resource Development Agency
1976 Statistical Data of the Uranium Industry. January.

Wyoming Department of Economic Planning and Development
1979 1978 Wyoming Mineral Yearbook. Cheyenne, Wyoming.

Mineral Fuels Taxation Issues and Revenues

Bingman, Anne K.
1970 "New Mexico's Effort at Regional Taxation of Extractive Minerals." Natural Resources Journal. Vol. 10, No. 3. July.

Boyle, Gerald J.
1977 "Taxation of Uranium and Steam Coal in the Western States." Non-Renewable Resource Taxation in the Western States, edited by Albert M. Church. Cambridge, Mass.

Carlisle, D., "The Economics of a Fund Resource with Particular
1954 Reference to Mining." American Economic Review, Vol. 44: 595-616. September.

Commonwealth Edison, et al. vs. State of Montana, et al., No. 42657
1978 District Court of the First Judicial District of the State of Montana.

Cummings, R.G.
1969 "Some Extensions of the Economic Theory of Exhaustible Resources." Western Economic Journal. Vol. 7:201-210. September.

Dasqupta, P., and Heal, G.
1974 "The Optimal Depletion of Exhaustible Resources." Review of Economic Studies, Symposium on the Economics of Exhaustible Resources, pp. 3-28.

Duchesneau, Thomas D.
1975 Competition in the United States Energy Industry. Cambridge, Mass.: Ballenger Publishing Co.

Executive Office of the President, President's Council on Wage and Price Stability
1976 A Study of Coal Prices. Washington, D.C.: U.S. Government Printing Office.

Fisher, Anthony C., and Peterson, Frederick M.
1977 "The Exploitation of Extractive Resources: A Survey." The Economic Journal. December.

Gaffney, M., (ed.)
1967 Extractive Resources and Taxation. Madison, Wisconsin: University of Wisconsin Press.

Gillis, Malcolm, et al.
1978 Taxation and Mining. Cambridge, Mass.: Ballenger Publishing Co.

Gordon, Richard L.
1967 "A Reinterpretation of the Pure Theory of Exhaustion." Journal of Political Economy. Vol. 75:274-286. June.

Gray, L.C.
1914 "Rent Under the Assumption of Exhaustibility." Quarterly Journal of Economics. Vol. 28:466-489. May.

Hauser, R.F., and Potter, L.G.
1970 "More Escalation Seen for Coal Costs." Electrical World. August.

Herfindahl, Oris C., and Kneese, Allen V.
1974 Economic Theory of Natural Resources. Columbus, Ohio: Charles E. Merrill Publishing Co., 1974.

Hotelling, H.
1931 "The Economics of Exhaustible Resources." Journal of Political Economy. Vol 39:137-175. April.

Kelley, Donald R., (ed.)
1976 The Energy Crisis and the Environment: An International Perspective. New York: Praeger Publishers.

Lewis, T.R.
1976 "Monopoly Exploitation of an Exhaustive Resource." Journal of Environmental Economics and Management. Vol. 3:198-204. October.

Lopach, James J.
1978 "The Coal Tax Challenge." Montana Public Affairs Reort. Missoula, Montana: University of Montana, Bureau of Government Research. June.

McClure, C.E.
1966 An Analysis of Regional Tax Incidence, with Estimation of Interstate Incidence of State and Local Taxes. Princeton: University Microfilms (PhD. Dissertation).

1967 "The Interstate Exporting of State and Local Taxes: Estimates for 1962." National Tax Journal. March.

Montana Department of Administration
1979 Montana's Financial Report 1977-78. Helena, Montana.

Montana Department of Revenue
1979 Report of the State Department of Revenue. Helena, Montana.

Montana Office of the Legislative Fiscal Analyst
1979 Budget Analysis: 1981 Biennium. Helena, Montana.

Mortensen, Ronald W.
1977 "Coal Taxation in the United States." Utah Economic and Business Review. Vol. 37:1-6. January.

Peterson, F.M., and Fisher, A.C.
1977 "The Exploitation of Renewable and Nonrenewable Resources." Economic Journal. pp. 655-661. December.

Post Oak Oil Co. vs. Oklahoma Tax Commission.
1978 575 p. 2d 964.

Rand Corporation.
1976 Coal Development and Government Regulation in the Northern Great Plains: A Preliminary Report. Santa Monica.

Real Estate Research Corporation
1977 State Laws Concerning Energy Conversion and Mineral Extraction. Chicago. September.

Schulze, William D.
1974 "The Optimal Use of Nonrenewable Resources: the Theory of Extraction." Journal of Environmental Economics and Management. Vol. 1:53-73.

Scott, A.D.
1953 "Notes on User Cost." Economic Journal. Vol 63:368-384. June.

Shelton, Robert B., and Morgan, William C.
1977 "Resource Taxation, Tax Exploration and Regional Energy Policies." Natural Resources Journal. Vol. 17, No. 2. April.

Solow, R.M.
1974 "The Economics of Resources or the Resources of Economics." American Economic Review. Vol. 64:1-14. May.

Stiglitz, J.E.
1975 "The Efficiency of Market Prices in Longrun Allocations in the Oil Industry." Studies in Energy Tax Policy, edited by G.M. Brannon. Cambridge, Mass.: Ballenger Publishing Co.

1976 "Monopoly and the Rate of Extraction of Exhaustible Resources." American Economic Review. Vol. 66. September.

U.S. Department of Commerce, Bureau of the Census.
1977a 1977 Cnesus of Governments. Governmental Finance Vol. 4. U.S. Government Printing Office.

1977b State Tax Collections. U.S. Government Printing Office.

U.S. Federal Energy Administration
1976 National Energy Outlook. Washington, D.C.: U.S. Government Printing Office.

The Wall Street Journal
1979 "Westinghouse Wins Round with Ruling Against Nine Foreign Uranium Concerns." December 8.

The Washington Post
1977 "Boom in Strip Mining: Windfall for Montana." May 22.

Weinstein, M.C., and Zeckhauser, R.J.
1976 "The Optimal Consumption of Depletable Natural Resource." Quarterly Journal of Economics. Vol. 89:371-92. August.

Wyoming Department of Administration and Fiscal Control
1978 Wyoming Tax Revenue Report. Cheyenne, Wyoming.

Resource Economics and Externality

Abt Associates.
1975 Social Assessment Manual. Prepared for the U.S. Department of Reclamation. Cambridge, Mass.

Bohn, P.
1972 "Estimating Demand for Public Goods: An Experiment." European Economic Review. Vol. 3.

Brookshire, D.; Ives, B.; and Schulze, W.
1976 "The Valuation of Aesthetic Preferences." Journal of Environmental Economics and Management. Vol. 3, No. 4.

Coase, R.
1960 "The Problem of Social Costs." Journal of Law and Economics. Vol. 3:1-44. October.

Coombes, N., and Biswas, A.
1972 Evaluation of Environmental Intangibles: Review of Techniques. Ottawa: Policy, Planning, and Research Service, Environment Canada.

Davidson, P.
1972 "The Valuation of Public Goods." In R. Dorfman, (ed.), Economics of the Environment. New York: W.W. Norton & Company.

Davis, Otto A., and Kamier, Morton J.
1972 "Externalities, Information, and Alternative Collectives." Economics of the Environments: Selected Readings. Robert Dorfman and Nancy Dorfman, (eds.). New York: W. W. Norton and Co., Inc.

Finsterbusch, Kurt, and Wolf, C.P.
1977 Methodology of Social Impact Assessment. Stroudsburg, PA: Dowden, Hutchinson, and Ross, Inc.

Freeman, A. Myrick
1979 The Benefits of Environmental Improvement. Baltimore: Johns Hopkins University Press.

Gregor, J.
1977 "Intra-urban Mortality and Air Quality: An Economic Analysis of the Costs of Pollution. Induced Mortality." Center for the Study of Policy, Pennsylvania State University.

Heinz, H.T. Jr., Hershaft, A., and Horak, G.C.
1976 National Damages of Air and Water Pollution. A report to the U.S. Environmental Protection Agency, Enviro Control, Inc. Rockville, Maryland.

Howe, C.W.
1979 Natural Resource Economics. New York: Wiley & Sons, Inc.

Kneese, A., and Schultz, C.
1975 Pollution, Prices and Public Policy. Washington, D.C.: The Brookings Institution.

Krutilla, J.V., and Fisher, A.C.
1975 The Economics of Natural Environments. Baltimore: Johns Hopkins University Press.

Lave, L., and Seskin, E.
1977 Air Pollution and Human Health. Baltimore: Johns Hopkins University Press.

Lin, S.A., (ed.)
1976 Theory and Measurement of Economic Externalities. New York: Academic Press.

Michelson, I. and Tourin, B.
n.d. "Comparative Methods of Studying the Costs of Controlling Air Pollution." Public Health Reports. Vol. 81.

Mishan, E.
1971 "The Postwar Literature on Externalities." Journal of Economic Literature. Vol. 9:1-28. March.

Pigou, A.
1932 The Economics of Welfare. New York: Macmillan. Reprinted 1952.

Power, T.
1978 "The Economic Value of the Quality of Life in Montana: A Preliminary Reconnaissance." Missoula, Montana: University of Montana.

Randall, A., Ives, B., and Eastman, E.
1974 "Bidding Games for Valuation of Aesthetic Environmental Improvements." Journal of Environmental Economics and Management. Vol. 1.

Rausser, G., and Zerbe, R.
1974 "Takes as Solutions to Externalities." Urban Economics Paper. University of Chicago. April.

Ridker, R.
1967 Economic Costs of Air Pollution. New York: Praeger Publishers.

Thaler, R.H., and Rosen, S.
1976 "The Value of Saving a Life: Evidence from the Labor Market," in N.E. Terleckyj, ed., Household Production and Consumption. New York: Columbia University Press.

U.S. Environmental Protection Agency
1974 Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-71. Research Triangle Park, North Carolina.

University of Wyoming, The Center for Urban and Regional Anaysis of Institute for Policy Research
1979 Socioeconomic Longitudinal Monitoring Project: Final Report. Prepared for the Old West Regional Commission. Laramie, Wyoming. June.

Wingo, L.
1973 "The Quality of Life: Toward a Microeconomic Definition." Urban Studies. Vol. 10.

APPENDIX A
ANNOTATED HISTORY
OF MINERAL FUELS TAXATION
FOR NINE WESTERN STATES

APPENDIX A. ANNOTATED HISTORY OF MINERAL FUELS TAXATION FOR NINE WESTERN STATES

The Western states have a long history of mineral development and subsequent taxation of this economic activity. Many states, other than the Old West states discussed in Chapter 4, have taken interesting approaches to the problem of mineral fuels taxation; in this appendix, the history of that taxation is outlined for nine states. These states are: Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oklahoma, Texas and Utah. In addition, Table A.1 lists all thirteen states that were investigated and some pertinent information regarding the types and rates of the taxes.

Arizona

The first tax levied on the production of mineral fuel resources in Arizona was established in 1935. The tax, called a transactions privilege tax, was set at 1 percent of the gross receipts of persons engaged in the production of coal, oil, natural gas or any other valuable mineral (1935 Arizona Sess. Laws, Ch. 77, Section 2).

Following enactment of the transactions privilege tax on mining, two more excise taxes were extended to mining activities (see Table A.1). In 1959, the education excise tax was imposed at a rate of ½ of 1 percent of gross receipts (1959 Arizona Sess. Laws, Ch. 89) of mining activities. In 1967, the special excise tax for education was imposed at a rate of ½ of 1 percent of the gross receipts from mining activities (1967 Arizona Sess. Laws, 3rd S.S., Ch. 8, Section 2). The special excise tax for education was increased in 1974 to 1 percent (1974 Arizona Sess. Laws, 1st S.S., Ch. 2, Section 13). The excise, or severance, taxes on mineral production are in addition to ad valorem taxes levied by the state and local governments.

California

The state of California first established a severance tax on mineral production in 1915. The tax was imposed on the production of oil and gas and was levied at a uniform rate per barrel of oil, or per 1,000 cubic feet of gas produced in the previous year. In addition, individuals owning oil-producing properties were charged a tax at a uniform rate per acre. The rates are set annually by the State Department of Conservation, with revenues to go toward the . . . "protection of the natural resources of petroleum and gas from waste and destruction" (1915 Cal. Stats., Ch. 718). The revenues typically account for approximately 0.02 percent of total state revenue. Some California cities levy severance taxes on oil production. These taxes currently vary between three and ten cents per barrel.

Colorado

Colorado established its first severance tax on mineral fuels in 1913. The tax was imposed on coal at a rate of 1/3 of $.01 per ton of coal extracted (1913 Colo. Sess. Laws, Ch. 56, Section 167).

In 1935, the severance tax on coal was raised to 4/10 of $.01 per ton (1935 Colo. Sess. Laws, Ch. 88), and in 1951, the tax was again increased to 7/10 of $.01 per ton. Receipts from the coal severance tax were paid to the Coal Mine Inspection Fund.

Colorado also instituted a severance tax in 1953 on the gross income from the production of crude oil and natural gas. The tax was imposed on the value of gross production and was levied in a graduated fashion* (1953 Colo. Sess. Laws, Ch. 352).

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*The schedule of tax rates imposed was as follows:

GROSS INCOME	RATE
first $ 24,999	2%
$ 25,000 - 99,999	3%
100,000 - 299,999	4%
300,000 and over	5%

Both the coal severance tax and the oil and gas production tax were replaced in 1977 with a simple, broader-based severance tax, covering metallic minerals, coal, oil and gas, molybdenum, oil shale, rock, sand, gravel, limestone and dolomite.

In addition to the severance tax on mineral production, Colorado also imposes an oil and gas conservation tax on oil and natural gas. When first levied in 1951, the tax was based on the physical quantity of the minerals produced (1951 Colo. Sess. Laws, Ch. 230). In 1959, the tax was changed from a per-unit basis to a value of gross production basis (1959 Colo. Sess. Laws, Ch. 187).

Idaho

Idaho imposed its first mineral severance tax in 1935. The tax was set at 3 percent of net proceeds from the production of coal and other precious and valuable metals or minerals (1935 Idaho Sess. Laws, 1st. E. S., Ch. 65). In 1972, the rate was reduced to 2 percent of net proceeds (1972 Idaho Sess. Laws, Ch. 99).

In addition, the Idaho legislature, in 1963, enacted a severance tax on oil and gas. The oil and gas severance tax was to be levied at not greater than ½ of $.01 per barrel of oil or 50,000 cubic feet of natural gas produced (1963 Idaho Sess. Laws, Ch. 148, Section 17).

Nevada

Prior to 1953 the only tax imposed on mineral resources was the property tax. The Nevada Constitution, as adopted in 1864, provided that only the proceeds of mining claims and mines should be assessed for taxes.

In 1953, Nevada enacted a severance tax on the production of oil and gas (1953 Nev. Stats., Ch. 202, Section 15). The tax, which applies today, is levied on the physical amount of oil and gas produced. The tax is levied at a rate of ½ of $.01 per barrel of oil produced, or per 50,000 cubic feet of natural gas.

Legislative action in 1979, authorized the State Board of Health to levy fees on uranium mines to pay the administrative costs of regulation and licensing.

New Mexico

New Mexico first taxed the production of mineral resources in 1935 through a resource excise tax. The original tax was imposed at a rate of 2 percent of the value of gross receipts of oil and natural gas producers and ¼ of 1 percent of the gross receipts from coal and all other mining (1935 N.M. Laws, Ch. 73).

Between 1935 and 1969, the resource excise tax was amended several times, changing the rate of the tax. In 1941, coal production was removed from the tax, but was reinstated in 1969.

In 1937, New Mexico enacted a severance tax on the gross value of mineral production, in addition to the resource excise tax. The original severance tax was imposed at a rate of 2 percent of the gross value of oil and gas production and 1/8 of 1 percent of the value of coal and other minerals produced (1937 N.M. Laws, Ch. 103).

In 1949, the tax rate on oil and gas was raised to 2.5 percent, and a $200,000 valuation exemption was authorized (1949 N.M. Laws, Ch. 65).

In 1951, uranium was included in the severance tax (1951 N.M. Laws, Ch. 24), and the tax rate on uranium production was raised from 1/8 to 2.5 percent in 1957 (1957 N.M. Laws, Ch. 79).

In 1959, the severance tax on oil, gas and liquid hydrocarbons was replaced by two other taxes, also based on the value of gross production. The oil and gas conservation tax was originally imposed at a rate of 14/100 of 1 percent of the gross value of production (1959 N.M. Laws, Ch. 53, Section 1). The other tax, called the oil and gas emergency

school tax, imposed a charge of 2 percent of the gross value of oil, natural gas and liquid hydrocarbons. Since then, both taxes underwent changes in their rates, with the present conservation tax rate established at 19/100 of 1 percent and the emergency school tax rate of 2.55 percent.

In 1974, the severance tax rate imposed on coal was increased from 1/8 of 1 percent to ½ of 1 percent.

Another change in the rate of severance taxation of coal was enacted in 1977. The 1977 amendments provided for split tax rates for the production of steam coal and the production of metallurgical coal. The new tax rates were based on the physical amount of production, with steam coal taxed at $.38 per ton and metallurgical coal taxed at $.18 per ton. The 1977 amendments also modified the manner in which uranium is taxed. The present severance tax imposed on uranium, as enacted in 1977, is based on a graduated schedule of inventory tax rates based according to the quality as measured by the unit price of the ore removed* (1977 N.M. Laws, Ch. 102, Sections 6-9, 14).

Mineral property in New Mexico is also subject to the ad valorem property tax.

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*Taxable value of U_3O_8:

over	but less than	Tax per pound
$ 0	$ 5.00	1.0%
$ 5.00	$ 7.50	$0.05 + 1.6% of excess over $ 5.00
$ 7.50	$10.00	$0.09 + 2.0% of excess over $ 7.50
$10.00	$15.00	$0.14 + 3.0% of excess over $10.00
$15.00	$20.00	$0.29 + 4.0% of excess over $15.00
$20.00	$25.00	$0.49 + 5.0% of excess over $20.00
$25.00	$40.00	$0.74 + 7.0% of excess over $25.00
$30.00	$30.00	$1.09 + 9.0% of excess over $30.00
$40.00	$50.00	$1.99 + 12.5% of excess over $40.00
$50.00		$3.24

Oklahoma

Oklahoma first levied a tax on the production of mineral fuels in 1910. The tax, called the gross production tax on minerals, was imposed on the gross receipts from the production of mineral oils, natural gas and coal at a rate of ½ of 1 percent. The original tax was in addition to the ad valorem taxes on land and improvements (1910 Okla. Sess. Laws, Ch. 44, Section 6). In 1915, the gross-production tax on minerals was made in lieu of ad valorem taxes on the land and on improvements of mines (1915 Okla. Sess. Laws, Ch. 107, Section A.1). In 1916, the gross-production tax was extended to cover ad valorem taxes on the minerals themselves (1916 Okla. Sess. Laws, Ch. 39).

In 1933, Oklahoma instituted a per-unit severance tax on oil production. The original excise tax was imposed at a rate of 1/100 of $.01 per 1,000 cubic feet of natural gas (1947 Okla. Sess. Laws, Ch. 462). The oil and natural gas excise tax was changed in 1976 from a per-unit tax to a tax on the gross value of production at a rate of .085 of 1 percent. (1976 Okla. Sess. Laws, Ch. 100).

In 1977, the Oklahoma legislature enacted a conservation tax on natural gas and casinghead gas. The tax is levied at $.07 per 1,000 cubic feet, less 7 percent of the gross value of each 1,000 cubic feet of gas, provided that the tax does not exceed 1/3 of the gross value of the natural gas. Ten percent of the receipts goes to a Special Conservation Fund, and 90 percent goes to the Oklahoma Employee's Retirement Fund.

Finally, in 1979 the legislature enacted a per-unit severance tax on coal of $.05 per ton to be paid to the Department of Mines for reclamation purposes (HB 1471)

Texas

In 1907, Texas imposed an occupation tax on oil. The tax was levied at ½ of 1 percent of the value of gross production of petroleum (1907

Tex. Gen. Laws, Ch. 18, Section 15). The occupation tax rate was modified several times, with the last change coming in 1959. The 1959 legislature changed the rate to the greater of $0.046 per barrel or 4.6 percent of gross value (1959 Tex. Gen. Laws, 3rd C.S., Ch. 1, Section 1).

Texas also enacted a production tax on oil in 1917 at a rate of 1/20 of 1 percent of gross value (1917 Tex. Gen. Laws, Ch. 30, Section 11). The base of the tax was subsequently changed to a unit count and is currently levied at 3/16 of $.01 per barrel (1935 Tex. Gen. Laws, Ch. 245, Section 1).

In 1931, an occupation tax on natural gas was enacted. The tax was initially imposed at 2 percent of the gross value of natural gas produced in the state (1931 Tex. Gen. Laws, Ch. 73, Sections 1-9). Several rate increases were made in the tax, the last of which occurred in 1969. The current occupation tax rate on natural gas is 7.5 percent (1969 Tex. Gen. Laws, Ch. 1, Art. 5, Section 1).

Utah

In 1937, Utah enacted a mining occupation tax of 1 percent of the gross value of oil, gas, or other hydrocarbon substances produced from a well or wells within the state (1937 Utah Laws, Ch. 101, Section 3). Uranium was added to the list of minerals taxed under the mining occupation tax in 1955 (1955 Utah Laws, Ch. 120). In 1959, the mining occupation tax rate was increased to 2 percent (1959 Utah Laws, Ch. 106).

In 1955, the Utah legislature enacted a severance tax on oil and gas. The original law fixed the tax at 2 mills per one dollar of gross value (1955 Utah Laws, Ch. 65, Section 16). In 1961, the authority to establish the tax rate was given to the Oil and Gas Conservation Commission. A tax-rate ceiling was also established at 2 mills per one dollar of gross value (1961 Utah Laws, Ch. 78).

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In-lieu of Property Taxes	Exemptions	Notes
Arizona	Transactions Privilege Tax	coal, oil, natural gas, and other valuable minerals	gross receipts	1%	1935	No		
	Education Excise Tax	coal, oil, natural gas and other valuable minerals	gross receipts	1/2%	1959	No		
	Special Excise Tax for Education	coal, oil, natural gas, and other valuable minerals	gross receipts	1/2% 1% (1974)	1967	No		
California	Severance Tax	petroleum and natural gas	unit of production	State mineralogist sets 3 rates: 1) fixed rate on each barrel of petroleum 2) fixed rate on each 1,000 cu. ft of gas 3) fixed rate per acre of petroleum land	1915	No		1929 amendment removed petroleum lands from the tax
Colorado	Severance Tax	coal	unit of production	1/3 of $.01	1913	No		

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemptions	Notes
Colorado (continued)		coal	unit of production	4/10 of $.01 (1935)				1935 amendment raised rate to 4/10 of $.01
				7/10 of $.01 (1951)				1951 amendment raised rate 7/10 of $.01
	Oil and Gas Production Tax	oil and natural gas	gross income	first $24,999 at 2% $ 25,000 - 99,999 at 3% $100,000 - 299,999 at 4% $300,000 and over at 5%	1953	No	Credit for ad valorem taxes paid for royalties, leaseholds and royalty interest but not for equipment or facilities.	
	Severance Tax	metallic minerals,	gross income		1977			1977 act replaces coal severance tax and oil and gas production taxes
		oil and gas,	gross income	same as oil & gas production tax		No	Credit allowed for payment of ad valorem taxes	
		coal	unit of production	60¢ per ton plus 1% increase (decrease) for every 3 point increase (decrease) in Wholesale Price Index		No	50% tax credit allowed for underground production. An additional 50% credit allowed on lignite. Credit for ad valorem taxes and payments to local governments to construct public facilities (1979).	
	Oil and Gas Conservation Tax	oil and natural gas	unit of production	1 mill per barrel of oil or 50,000 cu. ft. of nat'l. gas 2 mills 1 mill	1951	No		1953 amendment increas rate to 2 mills, 1959 amendments lowered rat to 85/100 of a mill or products produced from July 1, 1959 to June 1960. Raised rate to mill thereafter.

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemptions	Notes
Colorado (continued)	Severance Tax	oil shale	gross proceeds	Year / Percent First 1 Second 2 Third 3 Fourth & Over 4			First 15,000 tons per day of oil shale or 10,000 barrels of shale oil produced from in situ methods allowed 25% tax credit	
Idaho*	Mining License Tax	coal and other precious metals or minerals	net proceeds	3% 2% (1972)	1935	No		
	Oil & Gas Conservation Tax	oil and natural gas	unit of production	not greater than $.005 per barrel or 50,000 cubic feet	1963	No		
Montana	Mining License Tax	coal, other materials	unit of production	$.05 per ton	1921	No	50,000 tons (1939)	
							Credit up to 1/2 the reasonable value of reclamation (1967)	1967 amendment limited tax to strip mines only

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemptions	Notes
Montana (continued)	Coal License Tax (name changed to Severance Tax on Coal in 1975)	coal	unit of production and value	Btu/lb — Rate 6,000 or less — $.04 6001 - 7500 — .06 7501 - 9000 — .08 9001 and over — .10 (1971)			Exemption reduced from 50,000to5,000 tons also tax credit ceiling imposed of $.01 per ton (1971)	Tax rate was changed in 1971 to reflect heatin quality of coal
				Btu/lb — Rate 7000 or less — $.12 7001 - 8000 — .22 8001 - 9000 — .34 9001 and over — .40 (1973)			Reclamation credit removed (1973)	Tax rates were changed in 1973. Also $.01/ton to be distributed to counties. 1974 amendment increased county share to $.03/ton.
				Rates modified in 1975 and are different for strip and underground mines (see Chapter 3)				
	License Tax on Production of Oil (1921) (name changed to Oil & Gas Severance Tax (1975))	oil	gross value	1% 2% on value of 1st 450 barrels and 2½% on value thereafter	1921 1923			
				2.1% on value of 1st 450 barrels and 2.65% on each barrel thereafter	1969			

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemptions	Notes
Montana (continued)		gas (1975)	gross receipts	2.65%				Natural gas added to tax in 1975 which replaced the Natural Gas Distributor's Tax. 1977 amendment changed the split rate on petroleum from the 1st 450 barrels to $6,000 per lease per quarter.
	Oil & Gas Conservation Tax	oil and natural gas	unit of production	1/4¢/barrel for petroleum from wells producing less than 25 barrels per day. 1/2¢/barrel for wells producing more than 25 barrels par day. 1 mill/10,000 cubic feet of natural gas Oil and Gas Commission authorized to establish rates with old rates as ceilings (1961) Limits changed to 3/8¢ and 3/4¢ on petroleum; 2 1/2 mills per 10,000 cubic feet of natural gas or 5 mills per 10,000 cubic feet (1973)	1953	No		1961 amendment authorized Oil and Gas Commission to establish rates.

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemptions	Notes
			gross value (1977)	Limits changed to 2/10 of 1% of the gross value of each barrel of petroleum and on each 10,000 cubic feet of gas (1977)				1973 amendment changed rate on natural gas to 2 1/2 mills on gas marketed for 15¢ per 10,000 cubic feet. 5 mill rate on all other gas.
Nebraska	Oil & Gas Severance Tax	oil and natural gas	gross value	2%	1955	No		
Nevada	Oil & Gas Conservation Tax	oil and natural gas	unit of production	$.005 per barrel of oil $.005 per 50,000 cubic feet of natural gas	1953	No		
New Mexico	Resource Excise Tax	oil, natural gas coal and other mining	gross receipts	2% for oil & gas ½% for coal and other ½% for other (1959) 3/4% for other (1966)	1935	No	If taxes are paid, exempt from payment of privilege and compensatory taxes.	1941 amendment removed coal from tax. 1959 amendment removed oil and gas from tax. 1966 amendment raised rate to 3/4%. 1969 amendment reinstated coal.

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
New Mexico	Excise Tax (name changed to Severance Tax in 1961)	oil, natural gas coal and other mining	gross value	2% for oil and gas 1/8% for coal 2½% for oil and gas (1949)	1937	No	$200,000 (1949)	1949 amendment increased tax rate on oil and gas to 2½% 1951 amendment included uranium and removed $200,000 exemption. 1959 amendment replaced severance tax on oil, natural gas and liquid hydrocarbons with oil and gas conservation tax and oil and gas emergency school tax. 1961 amendment limited exemptions for hoisting, and loading expenses to 50% of gross value; also raised uranium tax rate to 1%
		uranium (1951)		1/8% for uranium (1951) 1/2% for uranium (1957) 1% for uranium (1961)				

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
New Mexico	Severance Tax			1/2% on coal (1974) $.38 for steam coal and $.18 for metallurgical coal (1977)				1974 amendment raised severance tax rate on coal to 1/2% 1977 amendment changed coal rate to $.38 per ton of steam coal and $.18 per ton of metallurgical coal. 1977 amendment also established taxable value for uranium at full gross value without any deduction.
	Oil and Gas Conservation Tax	oil and natural gas and liquid hydrocarbons	gross value	14/100 of 1%	1959	No		Replaced Severance Tax on oil, gas and liquid hydrocarbons
		uranium and geothermal (1975)		19/100 of 1% (1977)				1977 amendment changed rate to 19/100 of 1% also defined gross value of uranium at 25% of gross value.

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu to Property Taxes	Exemption	Notes
New Mexico (continued)	Oil and Gas Emergency School Tax	oil, natural gas and liquid hydrocarbons	gross value	2% 2.55% (1963)	1959	No		1963 amendment changed rates to 2.55%.
	Oil and Gas Severance Tax	oil, natural gas and liquid hydrocarbons	gross value	2¼%	1959	No	Royalties and expenses	
				3 3/4% (1974)				1974 amendment changed rate to 3 3/4%
			unit of production (1977)	$.05 per 1,000 cubic of natural gas and $.45 per barrel of oil (1977)				1977 amendment changed rate to $.05 per 1,000 cubic feet of natural gas and oil to $.45 per barrel.
North Dakota	Oil Properties Tax (changed to Gross Production Tax in 1953)	oil, natural gas	net value (1937)	6%	1937	Yes except on the land		1953 amendment changed basis of value from 1937 law which fixed value by "capitalizing" the total net earnings of the previous calendar year at the rate of 6%
			gross value (1953)	4 1/2% (1953)				

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
North Dakota (continued)		oil, natural gas	gross value (1953)	5% (1957)	1937	Yes except on the land		1957 amendment raised rate to 5%
	Coal Severance Tax	coal	unit of production	$.50 per ton of coal plus an additional 1% increase for every 3 point rise in the Wholesale Price Index (1975)	1975	No		1975 law in lieu of sales and use taxes. Original law effective for two year period.
				$.65 per ton of coal plus an additional 1% increase for every 1 point increase in the Wholesale Price Index (1977).				1977 law extended tax for two more years and changed rate.
				$.85 per ton of coal plus an additional $.01 increase per 4 point increase in Wholesale Price Index (1979).				
Oklahoma	Gross Revenue Tax (name changed to Mining Production Tax in 1915 and Gross Production Tax in 1935).	petroleum, other mineral oil, natural gas, coal	gross receipts	1/2 of 1%	1910	No		
				3/4 of 1% (1913) except coal		Yes (1915) except the land		1913 amendment raised rate to 3/4 of 1% except on coal
	Mine Reclamation Tax	Coal	unit of production	$.05 per ton	1979	No		

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
Oklahoma	Production Tax on Minerals	petroleum, other mineral oil, natural gas, coal	gross receipts	2% (1915)		Yes except the land (1915)		1915 amendment removed coal from tax; increased rate to 2% and made the tax in lieu of ad valorem taxes
				3% (1916)				1916 amendment raised rate to 3%
								1935 amendment raised rate to 5%
		uranium (1963)	gross value	5%				1963 amendment added uranium taxed at 5% of gross value
				7% (1971)				1971 amendment raised rate on oil and gas to 7%
	Excise Tax on Oil and Gas	oil	unit of production	1/8 of $.01 per barrel	1933	No		1943 amendment raised rate to $.001 per barrel
				$.001 per barrel (1943)				
								1947 amendment added natural gas to tax

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
Oklahoma (continued)	Excise Tax on Oil and Gas	natural gas (1947)	unit of production	1/100 of $.01 per 1,000 cubic feet		No		1949 amendment raised rate on gas to 2/100 of $.01 per 1,000 cubic feet and lowered oil to 1/8 of $.01 per barrel
				2/100 per 1,000 cu. ft and 1/8 of $.01 per barrel (1949)				
				7/32 of $.01 per barrel (1959)				1959 amendment raised rate on oil to 7/32 of $.01 per barrel
				4/100 of $.01 per 1,000 cu. ft (1967)				1967 amendment raised rate on gas to 4/100 of $.01 per 1,000 cubic feet
				1/4 of $.01 for oil and				
				5/100 of $.01 for natural gas (1974)				1974 amendment raised oil rate to 1/4 of $.01 and gas to 5/100 of $.01
		oil, natural gas	gross value	.085 of 1%				1976 amendment changed base to gross value

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
South Dakota	Mineral Tax	coal, uranium, petroleum, oil, natural gas	net profits	4%	1975	No	minerals worth up to $100,000	
	Severance Tax	oil, natural gas	gross value	3%	1977	No		1977 law removed oil and gas from earlier net profits tax
		coal, uranium, petroleum, oil and natural gas		4% (1978)				1978 amendment removed coal, uranium, petroleum, oil and natural gas from net profits tax and placed them under the severance tax at 4% gross value
				4.5% (1979)				
Texas	Occupation Tax on Oil	petroleum	gross value	0.5% (1907) 1 1/2% (1919)	1907	No		1919 amendment raised rate to 1 1/2%
				2% (1923)				1923 amendment raised rate to 2%

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(a)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
Texas	Occupation Tax on Oil	petroleum	gross value	greater of $.02 per barrel or 2% of value (1933)		No		
				greater of $.04125 per barrel or 4.125% of gross value (1941)				
				graater of $.046 per barrel or 4.6% of gross value (1959)				
	Occupation Tax on Natural Gas	natural gas	gross value	2%	1931			
				5.2% with minimum of 11/150 of $.01 per 1,000 cubic feet (1941)				
				7% with minimum of 121/1500 of $.01 per 1,000 cubic feet (1959)				
				7.5% (1969)				
	Production Tax on Oil	oil	gross value	1/20 of 1%	1917	No		
			unit of production	1/10 of $.01 per barrel (1931)				
				1/8 of $.01 per barrel (1934)				1931 amendment changed tax base from gross-proceeds to per-unit
				3/16 of $.01 per barrel (1935)				

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(s)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
Utah	Mining Occupation Tax	oil, gas, other hydrocarbon substances	gross value	1%	1937	No	$20,000	
		uranium (1955)	gross value	2%			$50,000 (1947)	
	Conservation Tax on Oil and Gas	oil, natural gas	gross value	(1959) 2 mills per $1.00	1955	No	Interests of U.S., State of Utah, Indian Tribes, Reprocessing or Recycling.	1961 amendment authorized Oil and Gas Conservation Commission to set rate up to 2 mills per $1.00
Wyoming	Oil and Gas Conservation Tax	oil and natural gas	gross value	rate not exceeding 2/5 of the mill	1953	No		
	Severance Tax	coal, trona uranium, petroleum, crude mineral oil, natural gas, other valuable deposits	gross value	6 1/4%	1969	No	Yes	
				1% on uranium and non-fossil fuels 3% on fossil fuels (1974)				1974 amendments changed tax rate.

TABLE A.1 Compendium of the History of Mineral Fuels Taxation in the Western States 1907 to the Present, by State and Type of Tax (Continued)

State	Tax	Minerals Subject To Tax	Base	Rate(a)	Year Enacted	In lieu of Property Taxes	Exemption	Notes
Wyoming	Coal Severance Tax	coal	gross value	graduated tax on coal (1975) at following rates Year / Rate 1974 0.4% 1975 0.8% 1976 1.2% 1977 1.6% 1978 & future 2.0%		No		1975 amendment removed tax on uranium and fossil fuels and instituted graduated tax on coal. Tax on other minerals shown under Minerals Excise Tax below.
	Minerals Excise Tax	uranium, trona coal, petroleum, natural gas, oil shale, other valuable deposits	gross value	a) 2% on uranium b) 2% on trona coal, petroleum, natural gas, oil shale, and other fossil fuels c) 2% on minerals in b (1975) 1977 rates as follows a) 2% for uranium, coal, petroleum, natural gas, oil shale or any other fossil fuels b) 2% for any valuable deposit except "stripper" production c) 1 1/2% for coal d) 1% for coal e) 1/2 % for coal f) 1 1/2% on coal, uranium, and trona (1977)	1975	No		1977 amendment changed rates

APPENDIX B
TECHNICAL ISSUES IN SOCIOECONOMIC AND FISCAL ASSESSMENT

APPENDIX B. TECHNICAL ISSUES IN SOCIOECONOMIC AND FISCAL ASSESSMENT

This appendix contains an expanded discussion of the issues presented in Chapter 7, Section 7.1. A detailed presentation of the technical issues and problems involved in socioeconomic and fiscal assessment is made here.

B.1. Economic/Demographic Relationships

The translation from a description of the proposed action to an estimate of the fiscal impact of the action proceeds through the several causally related steps illustrated in Figure 7-1. Because complete information on economic/demographic relationships does not exist, each of these steps is estimated based on assumptions. Further, because the steps are causally related, each step is estimated based on the results of the prior step. Largely because of data unavailability, therefore, the assumptions upon which the entire analysis is made are extremely important. The final results -- an estimate of social overhead costs (fiscal impact) -- are highly sensitive to assumptions, since any error can be magnified by the sequential structure of the analysis.

The causal relationship among the steps illustrated in Figure 7-1 can be briefly summarized. The annual labor requirements, payroll, and local purchases by the proposed action cause the gross economic impact within the region. This gross economic impact is spatially refined by accounting for the number of nonlocal workers attracted by the proposed action, their residential distribution and commuting patterns among communities within the region, the employment multiplier caused by local purchases of both the proposed action and its employees, and finally income flows among communities in the region due to trading relationships. The economic impact is then translated into demographic impact by accounting for the total number of nonlocal workers attracted to the various communities in the region and the family accompaniment rate for these nonlocal workers. The demographic impact will cause increased facilities

and services needs -- both public and private, that is, housing, schools, etc. These additional required facilities will be distributed spatially within a given community. Finally, the level of demand for public services and the spatial distribution of physical development will affect the level of state/local expenditures, while the economic value of total development and increased income resulting from the proposed action will affect the levels of state/local revenues.

Little substate data is available with which to estimate each factor in these causal relationships. Assumptions must be made for each step in the analytic process. Specific techniques, problems, assumptions and results are discussed in Section B.1.1.

The analysis is further complicated, however, in that local economic, population, and fiscal levels are dynamic, and may be growing, declining, or remaining stable irrespective of the proposed action. Effects of the proposed action will interact with other future changes occurring in the locality. It is necessary, therefore, to predict future levels for at least two scenarios: (1) a baseline forecast, which assumes that the proposed action does not occur, and (2) a forecast which includes the incremental changes in levels caused by the proposed action. The difference between the two forecasts can be taken as the impact due solely to the proposed action. In actuality, it may be necessary -- particularly for rural, economically undeveloped areas -- to forecast an additional, long range scenario based on the assumption that the proposed action will eventually discontinue operation. This issue is discussed in Section B.1.2.

B.1.1. Economic/Demographic Estimation

State and local government revenues and expenditures are functions of political, economic, and demographic variables in the region which those governments serve. Fiscal impact cannot, therefore, be reasonably estimated without prior estimation of the economic and demographic impact of a particular development. This section discusses the conceptual approach, technical difficulties, and previous results of economic/demographic estimation pertaining to energy development.

"Economic demographic estimation" is used here in a broad sense to include facilities/services impacts and land use impacts.

B.1.1.1 Conceptual Approach

Local impact begins with the proposed action, the most immediate effect of which will be the labor associated with the project, for both its construction and operating stages. Some portion -- which varies from locality to locality and from project to project -- will be supplied by local labor, while the remainder will be supplied by in-migrants. Moreover, jobs vacated by local labor to work on the project create other employment opportunities for local people and inmigrants. In addition, new jobs are often created to service the project or the new population associated with it. Together, these opportunities may induce local persons to enter the labor force who were not seeking work before -- thus, raising the local labor force participation rate.

One aggregate result of increased employment will be increased income and household purchases. Usually, not all these purchases will take place in the locality of the project: inmigrants are likely to distribute themselves (for a variety of reasons, including housing shortages and individual preferences) across several localities[1] within commuting distance of the project. A portion of these inmigrants will be accompanied by families, and population will increase in the several localities within commuting distance of the project site.

Moreover, the proposed action will have an impact apart from direct labor requirements -- purchases of materials, equipments, and services from regional suppliers. Such purchases, particularly for operating items which are regularly purchased, can cause increased employment and income in the locality of the supplier. Note that the locality of the supplier does not necessarily correspond with the locality of the proposed action. In fact, a development such as coal mining, for example, can be expected over time to cause secondary economic development by attracting other new industries and businesses which service it.

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[1] In more remote areas, there may be only one locality in which workers can reside.

It is likely that some of these new industries will have location requirements quite different from that of coal mining; their employment and income impact will occur in other communities within a larger trading region. It is extremely difficult to forecast the precise location of new industries attracted by coal development, however.

The total population increase associated with coal development and any secondary employment increase in other industries (as well as coal mining itself and businesses which locate in order to sell to mining) will purchase more goods and services than the predevelopment level of business- and household-serving sectors can provide. Therefore, these latter industries will also expand, increasing job opportunities and causing further inmigration. Two types of secondary development, therefore, will occur due to coal development: that directly related to coal development (basic activities) and that which produces goods and services consumed by the local economy (nonbasic activities).

Moreover, the local economy will be changing quite apart from coal and associated development. This requires that the analyst identify other basic industries, forecast employment growth in them, and calculate the nonbasic employment resulting from them.

In addition, within rural areas, such as are located in the Old West Region, it is very unlikely that all economic development and population growth will occur in the same locality as is the site of the original coal development. There exists an important spatial dimension to economic development, apart from commuting by workers. The spatial economy of the Old West Region is characterized by a hierarchy of trade and service centers, each offering a greater variety of goods and services as they increase in size. (Woerner, 1975; Chalmers et al., 1978; Borchert, Adams, 1963; Rust, Alonso, 1978.) Market areas of centers which offer different levels of goods and services overlap. Thus, while coal development is likely to be located in a rural area -- the trade center of which may offer a minimal variety of (essential) goods and services -- coal development employees who choose to reside in that same center will shop in other trade centers for higher-order goods and services. For example, if you live in Colstrip, Montana, you

probably buy your food and gas there, perhaps some clothing in Forsyth, and your furniture and car in Billings. Household-serving industries, therefore, will expand in higher-order trade centers as well as in the lower-order trade center where coal development is occurring. A parallel spatial development will occur for business-serving industries.

Associated with coal development, therefore, are secondary economic and demographic impacts which take place in a larger spatial area than for the initial development alone. Thus, the complete fiscal impact for coal development will include the costs and revenues to a large number of local governments as well as to state government.

The total population associated with employment as well as industrial expansion from each source noted earlier will generate increased demand for facilities and services -- housing, industrial and commercial buildings, transportation, and a host of public facilities and services. Note that increased demand does not necessarily imply a meeting by supply, because of various lags, particularly for public services. (This point will be discussed in more detail in Section B.2.) The land use distribution of new facilities has bearing on fiscal impact -- capital and operating costs increase with low density development, while different millage rates apply to different land uses, so that the land use mix will influence property tax revenues.

The total number of jobs demanded by coal development and its associated secondary development will cause employment-related migration to occur, as well as increasing the local labor force participation rate. Migration will take place until labor supply and labor demand is in balance, where the post-development balance includes a higher labor participation rate (and perhaps higher unemployment rate) than did the predevelopment balance. Working migrants will be accompanied by families -- in which the number and age of household members will vary according to a number of factors. But population grows through natural increase, as well as through migration. It is certainly the case that fertility rates will vary by age of mother, that death rates will vary by age of individual, and that both rates will vary by

race. Moreover, it is very likely that fertility rates and death rates will differ between native, predevelopment residents and development-attracted inmigrants.

Finally, the analysis of impacts causally flowing from coal development is complicated by the dynamic nature of economic development. Without the proposed action, the economy may still change -- whether growing, declining, or stable -- and the impacts resulting from economic change will occur. It is necessary, therefore, to forecast employment change in the absence of the particular development, from which forecasts of population change, facilities and services demand, and land use distribution follow. (These forecasts are compared with their counterparts under the coal development forecast scenario to calculate the impact due to coal development alone.) Forecasts of employment can be made by several techniques, discussed in more detail below. At a minimum, they require the identification of the basic, driving sectors of the local and regional economy, the forecast of employment in these industries, and the forecast of employment in nonbasic industries supported by basic sectors.

B.1.1.2 Technical Difficulties

The implementation of economic/demographic estimation is characterized by chronic data unavailability, which necessitates that the entire estimation process is laden with assumptions.

Description of the proposed action. An important component of information, upon which economic/demographic impact analysis is based, is the character of the proposed action, including construction and operation work force schedules, schedule of investments, value of local purchases and any relevant local-hire policies. This is usually provided by the developer. However, impact analysis is generally required well before the project is implemented, and often before detailed work plans are made. Necessarily then, specifications of the proposed action -- even those known to the developer -- are order-of-magnitude estimates. Moreover, largescale projects, such as coal mining, are often accompanied

by delays caused by materials shortages, unanticipated lengthy periods to obtain permits, etc. In order to stay on schedule for construction, the work force and rate of investment may be increased. Finally, energy development in the United States presently responds to a fluid, uncertain environment. National energy policy changes, fuel shortages or gluts, and rapid price fluctuations may significantly change the scope of a project. Moore (1979), reviewing energy impact assessment models, notes that it is the forecasts of proposed actions themselves which are the most uncertain component of such models, precisely because they are influenced by policy and other variables difficult to forecast. A more specific example is provided by the experience of the Bechtel Corporation, principal contractor of the Jim Bridger power plant in Rock Springs, Wyoming. Originally, Bechtel expected to construct one generating unit, for which construction employment would peak at 1,300 workers in 1974. In fact, two units were eventually constructed, and construction employment peaked at 3,000 workers in 1973. (Susskind and O'Hare, 1977).

Once the project work schedule has been provided, it is necessary to estimate that portion of the work force which will be composed of nonlocal workers, their family accompaniment rate (in terms of both number and age of family members), and their residential distribution among localities within commuting distance of the project site. The best data is available from three surveys of both construction and operating work forces for several large-scale projects in the United States and Canada (Mountain West Research, 1975; Wieland et al.,1977; DeVeny, n.d.). The naive assumption may be made that the sample represented in these surveys is representative of all projects, so that survey averages -- local/nonlocal composition of the work force, family accompaniment rate for nonlocal workers -- can be used. This naive assumption is not particularly valid. Mountain West Research, for example, surveyed fourteen projects. Nonlocal worker composition of the work force averaged 60.1 percent, but varied from 96.8 percent to 21.4

percent among individual projects. Family accompaniment averaged an additional 1.139 persons per nonlocal worker, but ranged from 1.869 persons to 0.211 persons for nonlocal worker on individual projects.

Typically, average relationships are used to estimate these parameters. However, even if an average relationship is statistically significant, the assumption must be made that such average relationships are representative of all projects. Unique conditions for the project (for example, whether it is a union project), the labor force characteristics of the locality where the project is sited, and the demographic characteristics of nonlocal workers hired for the project assure that some error is bound to occur. Since this error takes place at the beginning of the economic/demographic analysis, it repercusses through the remainder.

When the work schedule, the local/nonlocal work force composition and the residential distribution of workers has been estimated, the next step is to estimate income earned by workers. This can be done using anticipated average payroll information furnished by the developer, which is subject to similar errors as the work schedule (though the error may be less serious if average payroll is used). There are two reasons for estimating income earned directly from the project. First, coal development is a basic activity -- produced for consumption outside the local economy -- which causes an increase in nonbasic employment due to purchases by employees in the basic activity. Second, the entire increase in nonbasic employment caused by coal development will not take place in the locality where coal development takes place; coal development income will filter to other cities in the region because of trading relationships among cities in the regional trade hierarchy. Not all income, of course, is spent, which necessitates an estimate of spendable income. Nonlocal construction workers -- who are temporarily working in a locality away from their home -- are likely to spend less in the

locality (saving or sending the balance to their permanent residence) than do local workers. Limited data for the ratio of locally spent income to total income is available from one survey (Mountain West Research, 1975). The simplifying assumption that the average ratio obtained by survey is representative of nonlocal workers for all projects must be made, despite the fact that this ratio varied from 49.6 percent to 68.9 percent of total income among the projects surveyed. Finally, the information provided by this survey may be out of date.

Economic impact estimation. When the project work schedule, the local/nonlocal composition of the work force, the residential distribution of nonlocal workers, and the income earned and spent by all workers has been estimated, these direct project-related economic impacts must be allowed to repercuss throughout the regional economy. With the exception of census data, the smallest geographic area for which economic data is available is the county level. Three techniques are most often used: input-output (I-O), export base, and econometric models. It is not uncommon to find elements of all models combined into a single analytic structure (Beckhelm, et al., 1975).

The essential differences among the models lie in three areas: the extent of their industrial disaggregation, the data base from which they are estimated, and the questions they are best suited to answer.

I-O models are usually characterized by a high level of industrial disaggregation, they are estimated from interindustry transactions data at a point in time, and their principal orientation is to incremental analysis based on given charges in final demand. At the county level of analysis required for most economic/demographic assessments, an input-output model based on primary data is not likely to be an alternative. It is expensive and it suffers from the limitation of representing the structure of the economy at the time of the survey. This is a serious problem since a major consequence of the proposed action may be to change the structure of the local economy and render the interindustry transactions data irrelevant, especially in the case

of relatively large proposed actions in sparsely populated areas. The second issue is that input-output models become increasingly less appropriate as the level of industrial interaction in a region falls.

If the comparative advantage of I-O models is their ability to trace the interindustry implications of given changes in final demand, the comparative advantage of econometric models is in determining demand. They have little, if any, industrial disaggregation and their emphasis is on the aggregate level of production, the income induced by it, and on the resulting process of demand generation. The models are typically estimated from a large number of time series observations, and although they can easily be used for impact analysis, they are most often used at the state or multi-county level as a tool to project baseline levels of economic activity. Data required for these models are rarely complete enough for rural counties which are likely to experience coal development. These projected levels of final demand are then often used to drive industry models, interindustry models, revenue forecasting models, etc.

Given that neither input-output nor econometric models are likely to be applicable to rural counties where coal development is most likely, export base models are most often used. Export base models are less easy to characterize because of the variety of ways in which they can be constructed. Like input-output models, most estimating techniques are based on a point in time, although some techniques, like those suggested by Rosen and Mathur (1974), use time series data. The base model may result in anything from a single total employment to basic employment ratio (multiplier) to a matrix of multipliers specific to each nonbasic sector and each basic sector. The export base model is amenable to projecting either levels or incremental impacts and is commonly used in both ways.

The critical operation is the disaggregation of each sector's output or employment into basic (or export) and nonbasic components. In the extreme case (but not uncommon in the assessment literature), employment by one-digit industrial sector is categorized as basic or nonbasic on

a priori grounds, (e.g., manufacturing is basic, transportation is non-basic) and the ratio of total employment to basic employment is taken to be "the" multiplier, which is then applied to any change in exogenous employment to project the change in total employment. The more important issues ignored by this approach include the following:

-- Basic employment must be weighted to reflect earnings differentials, as noted earlier. It makes no sense to suggest that a change of one job in tourist-serving trade employment, representing an addition of $7,000 per year to basic income, will have the same effect on the economy as a change of one job in the heavy construction industry, representing an addition of perhaps $20,000 to basic income.

-- Explicit account must be taken of interindustry sales linked to basic activity.

-- Even a modest goal like "ballpark accuracy" demands rigorous attention to the split between basic and nonbasic. Much of manufacturing, for example, is nonbasic, while much of transportation is direct or indirect basic.

-- If significant growth is anticipated in the economy of the local impact area, it must be recognized that more goods and services will become available locally and that import substitution will take place, with the result that the multiplier will increase.

-- Finally, the economic size of the local impact area must be carefully examined because the size of the multiplier will vary considerably, depending on county size.

Each of these issues must be resolved in order to estimate the economic repercussions of coal development. Given the estimate of direct project-related impacts from coal development, the next step in the economic assessment process is to estimate the increase in employment in existing industries which sell goods and services directly to coal mining, as well as to estimate the probability that new coal-linked industries will locate in the region -- and, if so, to determine their probable employment and location. This type of secondary economic development may involve a structural change within the regional economy. One technique might be to use a national I-O model. Use of such a model assumes that the interindustry relationships at a given point in time are stable, and that the regional relationships are identical to the rational. Both of these are poor assumptions. Technological change and long-term price trends ensure that products will substitute for one

another, so that interindustry relationships are not stable over time. Moreover, the different mix of industries in a given region compared to the nation and transportation cost differentials across space ensure that regional industry relationships will not be identical to those of the nation. This is particularly serious if structural change within the region -- the relocation of new industries -- is likely. A more appropriate use for a national I-O model might be to merely identify industries which are strongly linked to coal.

Another appropriate technique to estimate the probability of secondary development would be the use of an industry location model, estimated by econometric techniques. Such a model could have a complex structure -- industry location is caused by numerous factors, including orientation to market, size of market, transport costs, labor skill requirements, etc. The model could be estimated using a cross-section of employment data for U.S. regions or a time-series of employment data for given regions. Numerous assumptions would be made: (1) depending on the precise structure of the model, simplifying assumptions would be made on the process of industrial location decision-making; (2) a host of technical assumptions required for specifying econometric models in terms of appropriate statistical analysis and data interpretation must be made in order to perform econometric modeling (Johnson, 1972); and (3) depending on the choice of a data base for estimating such a model, the assumption must be made that average relationships estimated for another region applies to the region of interest.

Even the best model estimated under such assumptions is not likely to accurately predict the magnitude of employment in coal-linked industries which could be attracted to the region. Forecasts should be verified by key informants in the region where coal development will occur. Another reason for interviewing key informants is that the best industry location model can reasonably estimate employment in such secondary development for the region as an entity; it cannot, however -- given the present state of the art -- predict the precise spatial

distribution of new industries within the region. The latter would have to be "guesstimated" by persons most familiar with the regional economy. Subjective perceptions and imperfect knowledge will invariably influence such "guesstimates."

The economic impact of new employment generated by coal development and new employment generated by the relocation or creation of industries which are directly linked to coal will cause a multiplier effect in the communities where they are located -- an increase in nonbasic industries which sell goods and services to households and business. This implies that the split between basic and nonbasic activities must be rigorously defined, which can present serious difficulties. It is not merely the case that one industry sells all of its output to consumers outside the locality while another industry sells all of its output to consumers within the locality. Tiebout, for example, found that each industry in Los Angeles in 1960 sold a percentage of its output to consumers both within and without the city's economy. The fabricated metals industry, for example, exported 42.6 percent of its output and sold 57.4 percent to local consumers (Tiebout, 1962). Nevertheless, the distinction is much easier to maintain in less complicated economies such as those which comprise the Old West Region.

How to estimate the distribution of basic and nonbasic production in each industry? A variety of methods exist. A local I-O model would be most appropriate, if one exists. Primary data can be collected from local firms on the origin of demand for their products. These two techniques make no simplifying assumptions; actual data for the region is used. An indirect measurement is the location quotient technique (in several variations), which calculates the production (or employment) in a specific industry in the region as a percentage of total regional production (or employment). The location quotient technique compares that percentage to its national counterpart. Assuming that the nation produces just enough for its own (nonbasic) consumption, the rationale is that if the region's percentage is greater than the nation's, the region is producing for export. The location quotient technique assumes that regional productivity, product mix, and local demand is identical to that of the nation (Tiebout, 1963).

Another technique for measuring the split between basic and non-basic employment is to use regression analysis. Employment in a given industry can be made a function of total local employment, local population, and national employment. The resulting coefficients, with appropriate manipulation, measure the split between basic and non-basic employment (Mather and Rosen, 1972). If enough observations are available, a time series can be used for the data base, and coefficients unique to the region can be obtained. Unfortunately, a universal problem for regional economics is the paucity of available data. Although employment data, for example, are collected at the county level in some industrial detail (by the U.S. Bureau of Economic Analysis and the U.S. Department of Labor in cooperation with state Bureaus of Employment Service), as geographic and industrial detail increases, the probability also increases that data will not be released, lest it reveal information about a specific firm. Therefore, in the detail required to accurately specify the basic-nonbasic split for a given industry, a complete time series may not exist, and there may exist too few observations to obtain statistically significant results.

Given an estimate of the basic-nonbasic split, three more steps remain in the economic assessment. First, the forecasted income in basic industries -- irrespective of coal and coal's influence -- must be made. Second, the nonbasic income multiplier(s) must be applied to the forecasts of all basic income to obtain forecasts for nonbasic income which are converted to employment using average wage rates. Third, the income flows among communities in the region due to trading relationships must be traced, and translated into increased trade and service employment for those cities which rank nearer the top of the regional trade hierarchy.

Income -- hence, employment -- in basic industries which is influenced by factors other than coal development can be forecast in several ways. The first is a regional econometric model, using time series data. The paucity of regional data, however, implies that regional econometric models are relatively simple -- particularly for less industrialized counties -- and they may be misspecified because of few observations and a lack of data for important variables. Moreover, regional econometric models are

usually driven by forecasts of national demand produced by national models, and are subject to the error produced by these national models.

A second forecasting method for basic sectors is the share approach (Tiebout, 1962). This approach assumes that the historical share of a given industry in the national economy will be maintained in the future. It ignores the possibility of productivity increases, regional price advantages, and regional structural changes. The region's historical share is merely applied to national forecasts. It is also, therefore, subject to the error produced by national models.

If a local input-output model exists, it can also be used to project basic income. In order to develop input-output projections, it is necessary to specify sales each industry can expect to make to final users of its product. Final sales projections must be made outside the model. Long-term applications of an input-output model are difficult because its interindustry relationships are unlikely to remain constant.

A technique which can be used to project basic employment directly is an eclectic ad hoc approach, in which information from several sources is examined. Knowledgeable persons within the local industry can be interviewed; forecasts are limited by the scope of their knowledge about future markets. State universities are the source of much relevant information in the future of agricultural production. Most universities also have a business or economic research unit which may forecast state employment projections. Finally, national projections can be examined. This ad hoc approach depends on the analyst's good judgment and ability to consolidate direct and indirect evidence for a given industry's future. Order-of-magnitude forecasts are possible.

One more type of basic employment remains to be quantified. Particularly in the western United States -- where population density is low over a large geographic area -- a clearly delineated trade

hiearchy among cities of various sizes has developed. Through established trading relationships, income earned in one locality in a trade area flows to other, larger communities. Trade and service employment in those larger communities -- a proportion of which is dependent upon those income flows from outside sources -- is clearly basic employment. Recent research (Chalmers, et al., 1978) has quantified the multipliers resulting from income flows among counties on levels of the trade hierarchy. The methodology used in this approach can be used to quantify trading relationships in any region. Extreme care must be used to define the regional trade area and the pattern of trading relationships among counties in that trade area; these can be defined through information obtained from key informants, and is subject to error caused by their subjective perceptions. In reality, income flows are among communities; available data, however, limits the methodology to counties. Since nonlocal workers spend less income locally than do permanent residents, the estimate of that proportion of nonlocal workers' income spent locally should be used to adjust their income before applying the quantified trade flows. Once trade flows have been quantified, the resulting redistribution of income can be translated into employment.

When all basic income -- both that influenced by coal development and that not influenced -- has been estimated and distributed among counties, the final step is to apply the nonbasic multiplier(s) to estimate nonbasic income. If the basic/nonbasic split in each industry has been carefully defined, all that remains is to translate income into employment. The rationale here is that it is purchases by households and businesses which support nonbasic employment. Therefore, basic employment must be weighted by income, or the resulting multiplier will be biased.

With the estimate of nonbasic employment, the total employment change in the local economies -- at the county level -- will have been calculated. The process should then be repeated, holding the effect of coal development constant. The difference between the two forecasts will be the employment impact resulting from coal development.

Demographic impacts. The total employment impact must be translated into population impact. Theoretically, labor demand should be balanced by labor supply -- by an increase in the local labor participation rate and by inmigration. Inmigration, births, and deaths are the components of population change. Before this can be done, the employment totals must be adjusted. The data used to estimate employment are on a place-of-work basis; labor force data is measured on a place-of-residence basis. Also, the employment predicted by the model is really jobs, not workers; workers, in fact, may hold more than one job. Ad hoc methods are usually used for these adjustments. All are variants of a simple ratio, using historical data, of employment by place-of-work over employment by place-of-residence. The ratio is applied to employment estimates. The assumptions are that the historical data are measured accurately, and that the ratio simply "washes out" conceptual differences.

The supply of labor must then adjust via: a) increased rates of labor force participation, b) changed unemployment, or by c) migration. The nature of the adjustment is of fundamental importance in determining the level and significance of socioeconomic impact that will be experienced by affected areas.

The determination of labor force participation was the subject of exhaustive study by Bowen and Finegan (1969) and continues to be of substantial interest to economists. Early research (see Dernberg and Strand, 1964) established support for the hypothesis that there was cyclical sensitivity in labor force participation rates. This was explained primarily in terms of a discouraged worker hypothesis that suggests that during periods of extended and high unemployment, unsuccessful searching for employment leads people to become discouraged and to drop out of the labor force. There have also been important secular changes taking place in the labor force participation of women in recent years.

The critical question for the purpose of impact assessment is the extent to which changed employment opportunities can be expected to

initiate increased participation in the labor force. Recent research by Renaud and Pham (1975) suggests that, at the regional level, changes in participation rates are much less important than migration in adjusting to changed employment opportunities. They see little evidence of a discouraged worker effect and argue instead that changes in participation rates seem to be much better explained by changes in real wages (Renaud and Pham, 1975). Kingston and Burgess (1976) come to similarly negative conclusions about the effect of the overall level of labor market tightness on regional participation rates, although they do show that age/sex specific employment opportunity variables seem to positively affect participation. Thus, while there is considerable evidence (Bowen and Finegan, 1969) that supports the notion that participation rates at the national level are endogenous with respect to changes in labor market tightness, at the regional level it is difficult to empirically identify this effect.

In the analysis of a local impact area, therefore, participation rates are seldom assumed to be an important source of adjustment to short term changes in the demand for labor. Changes in rates are usually postulated to keep up with national trends and, in the case where rates in a particular area are low relative to the national average, it is often assumed that there will be convergence toward national rates, especially in the context of significant improvements in employment opportunities.

Assuming that employment change has been determined and that changes in the labor force due to changed participation has been accounted for, the remainder of the employment change must come from migration or from a change in the number of unemployed. Analysis of adjustments in regional unemployment must recognize the openness of regional labor markets. At any given time, there will be regional variation in unemployment rates due to area differences in socioeconomic characteristics and in the secular trends affecting their economic base. A pattern of regional variation in unemployment rates is established, therefore, in response to these forces. If the pattern is disturbed, however, say by a localized increase in labor demand, the short term

reduction in the unemployment rate tends to be eliminated by immigration with the result that relative regional unemployment rates may end up much the same as before the localized increase in demand.

This leads to the notion that there may be some upper and lower bounds for the local unemployment rate, beyond which changes in local labor market conditions will be totally offset by migration as the interregional pattern of unemployment rates is re-established. The case study literature supports this idea although there remains much to be learned about the nature of the adjustment mechanism. For example, the National Association of Counties (1976) reports that, despite large increases in employment associated with construction of the Hope Creek Station in New Jersey, "unemployment has remained steady at 8.5 percent." A similar conclusion is reached by Purdy, et al. (1977).

Implicitly, the above discussion of labor force participation and of local unemployment suggests that if a project results in a significant change in the level of local employment, a large portion of the labor supply adjustment must come from migration. The analysis of migration is usually handled in three parts (Mountain West Research, 1978). First, since the mobility status of a construction workforce is a critical determinant of impact, it is separated out and subjected to explicit analysis along the lines discussed earlier. The second component of migration is largely independent of economic activity and can be very significant in affecting demographic change in some areas. Examples include migration into and out of educational institutions or military facilities, and retirement migration. The remaining category of migration is referred to as employment-related migration and is determined as a residual given the change in demand relative to the other sources of changed labor supply.

Labor supply, then, will be a function of employment-related immigration, change in unemployment, and increased labor participation rates. Data for immigration and participation rates is poor. That for migration can be found in the decennial U.S. Census, and in a sample by the U.S. Social Security Administration which is rarely

significant at the county level. Data on the labor force participation rate is nonexistent for subnational regions. Typically, the analyst either ignores the local participation rate, or uses its national counterpart, the local unemployment rate as a proxy, or both.

Labor supply can be balanced to labor demand -- under the assumption that the local unemployment rate remains constant -- by simply assuming migration occurs to fill the void. There is little reason to suppose that the unemployment rate will remain constant (Greenwood, 1975; Muth, 1971; Mazek, 1969).

Econometric approaches are appropriate to estimate the rate of net inmigration, given an initial unemployment rate and a forecast of employment opportunities. Such econometric techniques are (by necessity) based on data for other regions, since data for an individual county will be poor. The assumption necessarily must be made that average relationships estimated in such an equation, based on data for other regions at a different point in time, are applicable to the region of interest.

Econometric approaches to estimating migration rates can be quite sophisticated; it is possible to estimate migration rates for age-sex groups within the population. If such rates have not been estimated initially, it is necessary to make some assumptions in order to estimate the age-sex distribution of inmigrants at a later stage of the analysis. This is necessary for two reasons. First, population grows through migration and natural increase; fertility and death rates vary by age, race, and sex. Second, population groups -- or cohorts -- demand different government services. Because of unavailability of local data, state or national fertility rates and death rates must be used as proxies for their local counterparts. This may be particularly serious if vital rates for native residents and immigrants differ significantly. Finally, these vital rates must be projected. It is often assumed that they will converge to national forecasts.

Most of the assessment, to this point, will have taken place at the county level of analysis. The only community-level information

which is available and which has any direct applicability to economic/demographic estimation is population. Community population is counted in the decennial Census and, for incorporated communities, annually estimated by the U.S. Bureau of Census. The usual practice -- because it is the only available alternative -- is to allocate both economic and demographic projections to communities within the county, based on the community's share of county population in some base year or in the previous forecast year. The naive assumption must be made that population represents all economic and demographic phenomena.

When population is allocated to communities, it is translated into households if a housing analysis is desired. Like other demographic variables, persons per household information is scarce. Therefore, old local information (from the U.S. Census) or national estimates are often used.

Facilities/services and land use. The purpose of analyzing the implications of coal development on the availability and cost of public facilities and services is to provide information on the underlying demand for facilities and services.

The complexity and cost of community impact assessment procedures currently being used vary enormously. At one extreme, very simple rules of thumb based on average total cost per capita of all public services and facilities are being used. These techniques do not attempt to account for cost variations associated with differences in physical location, with the effects of excess capacity in existing facilities, or with economies or diseconomies of scale associated with changes in community size. Nor do they take into account the effects which rapid increases and decreases in demand associated with the short-term nature of project construction may have on the cost and availability of public services/facilities and housing. At the other end of of the spectrum are the attempts to construct comprehensive housing/land use models which try to deal with all aspects of the spatial distribution of economic and demographic activity. These models have

several serious problems. They are extremely expensive, they are very complex, and the key variables on which they are based (e.g., projected land prices and availability) are often not amenable to even reasonably accurate prediction. Examples of these models include that developed by Lowry at the Rand Corporation (1964); EMPIRIC which was developed for the Boston area, and PLUM, which was initially developed for use by the Bay Area Transportation Study in San Francisco (Goldner, et al., 1972).

Current practices in the housing assessment literature are very straightforward (Chalmers and Anderson, 1977). Total demand projections are based on average household size and distinctions are sometimes made between permanent residents and nonlocal construction workers. Demand by type of unit is then based on fixed coefficients applied to total projected demand. This data is obtained either from surveys or by assuming that the existing distribution does not change.

However, in spite of this seeming simplicity, present approaches have several drawbacks. Preferences for housing, both in terms of housing type and amenities, have often been confused with effective demand (ability and willingness to pay). If the preferences or tastes are mistaken for effective demand, projection errors will be made. A more serious problem results from the fact that supply has not been adequately accounted for as a constraint on effective demand with the consequence that availability effects are being mistakenly interpreted as demand parameters.

There has also been a failure to account for the effects of local government regulations and political decisions on the housing market. In addition, the availability of financing from local sources has typically been ignored as an important potential supply constraint. A further weakness of current procedures is their inability to take into account changes in the availability and price of land for housing development and changes in the price of existing housing attributable to local, short-term supply/demand conditions. Data for these variables simply do not exist. Finally, many impact assessment procedures assume

a static rather than a dynamic context. It is often necessary, particularly with regard to the construction in rural areas, in which the short-term and long-term economic/demographic effects are likely to differ markedly, to determine how the local housing market will change from the construction phase to the operation phase of the project. Such data is only available from surveys.

There are a number of technical issues regarding the estimation of demand for public facilities and services which will be discussed in more detail in Section B.2.2 below. Suffice to say here that data unavailability typically prevent the analyst from estimating demand precisely.

Conclusions regarding technical difficulties of economic/demographic estimation. The theory and empirical research of regional economics has progressed significantly in recent years. This progress has clarified the conceptual approach to economic/demographic impact assessment. However, severe data limitations at the local -- substate -- level force the analyst to make a rather large number of assumptions for each step of the estimation process. The necessity for these assumptions prevents the estimation of economic/demographic impacts due to coal development beyond order-of-magnitude precision. Depending on the validity of assumptions and the precise nature of assumptions made, results can vary tremendously.

B.1.1.3 Results

It is difficult to directly compare the results of complete economic assessments for actual coal development projects, simply because there is no case where more than one assessment has been made for the same project. Project work schedules and regions differ enough that a comparison of different projects to judge the volatility of impact assessment techniques is not meaningful. However, a hypothetical example for the same project, using different techniques, has been calculated by Mountain West Research (1979a).

There, a relatively simple example was illustrated. Given annual peak construction and operation work schedules for a hypothetical project, the total population increase associated with each work force was calculated. The estimation procedure involved making assumptions about the local/nonlocal composition of the work force, the family accompaniment rate of nonlocal project workers, the application of the basic/nonbasic multiplier, the calculation of inmigration for nonbasic support jobs, and the family accompaniment rate for nonbasic job inmigrants. Procedures were used which were recommended by Mountain West Research, Inc. (1979a), the U.S. Department of Housing and Urban Development (1976), and Briscoe, Maphis, Murray, Lamont, Inc. (1978). The results are presented in Table B-1. It was assumed that the construction peak force equals 1200 workers and that the operations force equals 130 workers.

TABLE B-1

Results of Three Economic/Demographic Techniques for the Same Project

Technique	TOTAL POPULATION INFLUX	
	Construction	Operations
Mountain West	1498	431
H.U.D.	4498	795
Briscoe, et al.	5851	1071

It is striking that the difference between the highest and lowest estimate differs by a factor of four. The point should be stressed that neither one nor the other set of assumptions is necessarily wrong. Any set would be correct under the appropriate circumstances. This example

illustrates, however, the tremendous variability in results that derives from different assumptions. In a full-scale economic/demographic assessment, this variability can be multiplied tremendously due to the causal flow among steps in the assessment procedure where the results of one step provide the base for calculations of the next.

B.1.2 Economic Development Cycle

An issue which was not addressed above, but which has direct bearing on the total costs associated with coal development is the point in a locality's economic development cycle that a project enters the economy. An economy may be growing, stable, or declining. The fiscal situation of state and local government is dependent, in part, on the stage of the economic development cycle. It is also possible for a project to significantly affect local economic development and alter the cycle.

B.1.2.1 Conceptual Approach

A growing economy starting from a small population base will experience inmigration of businesses and population, and will be characterized by construction -- both private and public. Property taxes are generally collected in arrears, after construction has been put in place. Therefore, public revenues from property taxes will typically lag the demand for public services. Moreover, the type of public services demanded will tend towards capital expenditures -- roads, sewer systems, etc. In a stable economy, public revenues and expenditures are more likely to be in balance; expenditures will tend to be for maintenance. A declining economy will experience outmigration, both of population and business. Income levels and the value of property will tend to fall; public revenues, therefore, will decrease. However, compared to those of a stable economy, public expenditures will tend to remain constant or even increase. Maintenance required for public infrastructure will remain constant. Higher unemployment and decreasing income levels are likely to increase per capita public expenditures for income maintenance and social services, relative to similar expenditures in a stable economy. In general, then, the growth

and decline stages of economic development are more expensive for state and local government than is the stable stage.

Development economists and economic historians generally accept the broad outlines of a three-stage theory of regional economic development. First, extractive industries (agriculture, forestry, and/or mining) develop. Second, manufacturing develops: initially, to process resources or to provide inputs to resource extraction, and then to provide inputs to the initial manufacturing industries, and so on. Eventually the requirements of resource-related manufacturing -- skilled labor, a transportation network, etc. -- develop to a point where manufacturing unrelated to the original resource is attracted to the area. Concurrent with all employment growth, services for businesses and households will develop; finally, in a mature economy, services will be the rapid growth sector. During the same time that its economy develops in these stages, a stable hierarchy of cities, each specializing in some aspect of the regional economy, evolves in the region.

While this outline is oversimplified, the essential point is that a mature economy produces more of the goods and services it needs (and thus becomes less dependent upon the national economy) than does a less developed economy. Most of the Old West Region remains in the first stage of development, with a hierarchy of trade centers servicing a generally extractive regional economy.

In this context, a model of economic decline for local areas (communities) hypothesized by Rust and Alonso (1978) is pertinent. Although the model is hypothetical, it provides a framework for discussing the possible impact of decline upon the fiscal condition of local governments.

1) Initially, the local area has a resource-based economy. It is dependent upon the national economy for its economic growth.
2) A stage of growth occurs which is conducive to future decline. The local resource gains unusual advantage in a

national market, accompanied by national demand for that resource. The local economy, as before, is dependent upon the national economy for its economic growth, but there occurs rapid growth in the sector of advantage, which leads to increased specialization in the lone resource. Nonlocal firms exploit the resource, and reinvest associated profits out of the area. Rapid population growth occurs, which accumulates a highly mobile, young, and fertile population. Household-serving businesses are created to serve the increased population.

3) The resource's advantage in the national market passes due to economic factors or exhaustion of the resource. If, by this time, the local economy has not developed to a point where it is relatively mature and self-sufficient, it is likely that long-term decline has begun. Production of the resource is likely to decline, although perhaps not to its initial level. Therefore, job growth stops (and may, in fact, decline); inmigration ceases.

4) A "shadow boom" occurs, in which migration adjusts the labor force, but population continues to grow due to births. Household-serving industries weaken. Income falls, since high-wage (extraction) job growth has stopped.

5) The stage of primary decline occurs. Migrants' children reach working age, seek jobs, are either unemployed or underemployed, or migrate. Since population is now declining, household-serving industries further decline, and employment fails even more. Rapid outmigration takes place, especially among the skilled, professional, and young.

6) A stage of inelastic decline is reached. Employment falls, but population cannot adjust fast enough because the migrant pool (consisting of the young and skilled) is depleted. A low outmigration rate and chronic unemployment and underemployment (primarily of older workers) results. This permanent labor surplus may attract "parasitic" industries. Thompson suggests that industries filter down through the national hierarchy of cities, seeking more remote locations only at a stage of their own evolution when their operations are so routinized that little management information and skilled labor are required. At this stage, they no longer need the advantages of a metropolitan location and seek cheap labor; but they have also passed their phase of rapid growth. There is a tendency, then, for remote areas to specialize in branch plants of older, low-wage, low-skill, low-growth industries. (Thompson, 1969.) The chronic labor surplus, with or without parasitic industries, contributes to downward social mobility in the stage of inelastic decline.

7) Finally, a stage of stabilization is reached, but only when the migrant population associated with the original boom ages

enough to pass out of the labor force and remove the labor surplus. The former boom industry has long stablized or disappeared, to be replaced, if at all, by branches of non-local firms and other low-wage industries. Routine out-migration of youth, particularly the best-educated, occurs. There exists a permanent depletion of the professional and technical service sector.

The Old West Region has continually experienced boom-bust cycles during its economic history -- gold and silver throughout the region during the 19th century, copper in Montana during the 20th century, and oil and gas in the Williston Basin during the 1950s, to cite a few well-known examples.

In terms of fiscal impact, several observations from the Rust-Alonso model may be made. The period between initial coal development and eventual stabilization, if decline does occur, is lengthy. Stabilization is not reached for a generation, the time it takes for growth-attracted migrants to completely pass through the labor force. Public revenues and costs are generally not in balance for growing and declining economies. Therefore, it is possible that the fiscal impact on local government due to coal development may be relatively expensive, not only during the initial growth phase, but for a generation following. It is possible, of course, that manufacturing or other basic industries unrelated to coal development may have located in the region, if enough time has passed since the initial coal development. Should such secondary development occur, it is more likely that the regional economy will stabilize after the initial locational advantage (low-sulfur, easily strippable coal in the context of a national energy shortage) has passed. It is unlikely, however, that the locational advantage could be maintained for the period required.

If no such secondary development occurs, the cost of local government is relatively more expensive in a second sense. Public expenditures in a growing economy are likely to be disproportionately large for infrastructure -- streets, water systems, sewer systems, etc. If the economy begins to decline without passing through a stabilization stage, the infrastructure will be greatly overextended, but will continue

to need maintenance. At the same time, public expenditures in a declining economy with high unemployment and low income levels are likely to be disproportionately large due to income maintenance and social services requirements.

B.1.2.2 Technical Difficulties

The remoteness and resource-based nature of local economies in the Old West Region suggests that the Rust-Alonso model of economic decline has some applicability. The Region's economic history reveals a pattern of boom-bust economies. In terms of estimating the fiscal impact of prospective coal development, the Rust-Alonso model strongly suggests that very long-term forecasts -- at least a generation into the future -- should be made. Such forecasts would have to establish whether secondary development -- unrelated to coal development -- occurs; if it does, precipitous economic decline, presumably, can be averted.

These requirements are beyond the current state of the art of economic/demographic forecasting. To estimate the development of unrelated industries requires: (1) estimating the extent to which coal development and its associated manufacturing accumulates agglomerative economic resources, such as a pool of skilled labor, a supply of ready capital, a transportation network, etc; and (2) estimating the probability that other industries will locate in the area because of knowledge of such resources, a ready market for their products, etc. Moreover, the timing of such development must be forecast, along with the timing of when coal production located in the area begins to decline. The decline of local coal production requires the long-term forecast of national energy developments; the energy market is one in which the effect of technological innovation and institutional constraints cannot be confidently estimated in the long-term.

An alternative to forecasting secondary development is to assume that it will not occur, and to forecast the fiscal impact of decline after an arbitrary period of initial growth. This "bust" forecast can be contrasted to one which assumes constant coal employment (e.g., a

stable economy) to derive the fiscal impact of decline.

B.1.2.3 Results

No assessment for any project has ever considered the cost implications of a shutdown of the project. The only empirical evidence which exists is very indirect. Rust and Alonso, using the 1970 U.S. Census, categorized the 133 counties in Montana, North Dakota, and Wyoming by the year in which each county attained its maximum population. For 23 counties, 1970 was the year of peak population; these counties were in the initial growth or "shadow boom" stages. For 30 counties, peak population was reached in 1950 or 1960; these counties were in the primary or inelastic stage of decline. For 38 counties, peak population was reached in 1930 or 1940; these counties were in the inelastic stage of decline. Finally, the peak population for 42 counties was reached over fifty years previously; these counties were in the stabilization phase.

The pattern presented by Rust and Alonso is consistent with their hypothesis. Montana, North Dakota, and Wyoming all have economies that are resource-based, but the causal relationship hypothesized by Rust and Alonso has not been empirically estimated. However, their argument is strong, the region has experienced decline, and the cost implications of project shutdown should be explicably considered in assessment practices.

B.2 Fiscal Relationships

Fiscal relationships -- to economic and demographic variables, and among fiscal variables -- are complex, numerous, and unfortunately, often not easily measured in the detail that complete analysis measures nor in the precision that practical usefulness requires.

Given the uncertainties inherent in economic, demographic, and fiscal impact assessment, an often used approach in fiscal analysis is the worst-case approach. Given a number of assumptions from which to choose at each step of the analysis, the worst-case approach will

use that assumption which causes the greatest impact. The rationale is that at least the facilities and services required for a given impact will not be underestimated. But the costs of overbuilding are a least as great as underpreparation. A useful fiscal assessment requires order-of-magnitude impact estimates, which are attainable with a careful analysis of theoretical relationships, a complete use of available data, and with a realistic choice of the assumptions necessary to fully utilize available data.

B.2.1 Governmental Interrelationships

As noted in Section B.1.1, in the interest of completeness, all local governments located in the trade area in which resource development occurs should be included in the analysis. However, public services provided for a given local area are delivered by state government as well as by local governments. Table B-2 lists typical public services provided to local areas, broken out by state-delivered services and local-delivered services. State administrative services are excluded from Table B-2.

Since some public services are delivered to a local area by state government, the estimation of fiscal impact is complicated. Since state-delivered services are affected by coal development, the corollary impact on state revenues by coal development should also be estimated. Another reason for estimating the coal development impact on state revenues is that state intergovernmental transfers are an important component of local government revenues; Table B-3 lists revenues by source to state and local governments. Of the thirteen general categories of state government revenues presented there, all but the insurance tax and inheritance tax can be affected by coal extraction, secondary development, or population attracted to the local area by coal development.

A reasonable technical approach is to isolate state revenues which are affected by coal-related development, and to forecast them as a function of coal development and other pertinent economic activities. Future levels of economic activity for other variables will have to be projected, assumed, or held constant; a "with" and "without" coal

TABLE B-2

State and Local Government:
Direct Delivery of Public Services in Local Areas[1]

STATE GOVERNMENT	LOCAL GOVERNMENT
EMPLOYMENT-RELATED SERVICES	
Job Placement & Training	
Unemployment Compensation	
Worker's Compensation	
HEALTH SERVICES	
Maternal & Child Health	Maternal & Child Health
Preventive Health	Preventive Health
Dental Health	Dental Health
	Hospitals & Personnel
	Emergency Medical Services
	Regulation & Licensing
WELFARE SERVICES	
Rehabilitation/Correction	Economic Assistance
Mental Health Services	Services to Aged
Services to Disabled	Services to Children & Youth
	Alcohol & Drug Abuse
	Other Social Services
EDUCATION	
Higher Education	Elementary Education
Vocational & Occupational Services	Junior High Education
	High School Education
HIGHWAYS & STREETS	
Highway Engineering	Street Engineering
Highway Maintenance	Street Maintenance
OTHER PUBLIC WORKS	
	Water Systems & Facilities
	Sewer Systems & Facilities
	Sanitation Collection
	Refuse Disposal Facilities
PUBLIC SAFETY	
	Police
	Fire
	Public Housing
	Zoning

TABLE B-2
(cont.)

STATE GOVERNMENT	LOCAL GOVERNMENT
RECREATION & CULTURE	
	Parks and Recreation
	Libraries
GENERAL GOVERNMENT	
	Financial Administration
	General Control

[1]Sources: Robert W. Burchell and David Listoken, The Fiscal Impact Handbook, The Center for Urban Policy Research, New Brunswick, New Jersey, 1978; State government directories, Montana, North Dakota, and Wyoming; personal communications, Montana Department of Health and Environmental Sciences and Department of Social and Rehabilitation Services.

TABLE B-3

State and Local Government:
Revenue by Source

STATE GOVERNMENT	LOCAL GOVERNMENT
OWN-SOURCE REVENUES	
1. Property Taxes	1. Property Taxes
- Real Property	- Real Property
--Private Structures	- Personal Property
--Gross Proceeds Tax on Mineral Development	
- Personal Property	
2. Personal Income Tax	2. Personal Income Tax
3. Corporation License Tax	
4. Business Franchise Taxes	
5. Highway Users Tax	
- Fuel Taxes	
- Registration Fees	
- GVW Fees	
- Special Users Fees	
6. Alcoholic Beverage Tax	
- Beer Tax	
- Liquor Excise Tax	
- Profits on State Liquor Stores	
7. Tobacco Tax	
8. Mineral Resource Taxes	
- Resource Indemnity Trust Tax	
- Coal Severance Tax	
- Oil & Gas Producers Severance Tax	
- Metalliferous Miners' License Tax	
- Cement License Tax	
- Micaceous Miners' License Tax	
- Coal Retailers License Tax	
9. Insurance Tax	
10. Inheritance Tax	
11. Unemployment Compensation Tax	
12. Sales Tax	3. Sales Tax
	4. User Charges
	- Water
	- Sewer
	- Electricity
	- Refuse Collection
	- Court Fees
	- Hospital Fees
	- Fees for School Lunches
	- Parking Fees
	- Recreation Fees

TABLE B-3
(cont.)

STATE GOVERNMENT	LOCAL GOVERNMENT
	5. Miscellaneous Revenues - Special Assessments - Sales of Property - Interest on Cash Balance - Fines - Forfeitures
INTERGOVERNMENTAL TRANSFERS	
13. Federal Transfers	6. Federal Transfers - Federal Revenue Sharing - Comprehensive Employment Training Act - Public Works Employment Act - Community Development Block Grants - Educational Assistance in Federal Impact Areas
	7. State Transfers - Sales Tax Redistribution - Income Tax Redistribution - Motor Fuels Tax Redistribution - Cigarette and Alcohol Tax Redistribution - Corporation Income Tax Redistribution - Road and Road Lighting Aid - Public Utilities Franchise Tax Redistribution - Aid to Urban or Rural Areas - Educational Support --Via Variable Guarantee -- Categorical Aid -- Elementary and Secondary Education Act Subsidies

1

Sources: General categories for state taxes and all local revenues are taken from Robert W. Burchell and David Listokin, The Fiscal Impact Handbook, The Center for Urban Policy Research, New Brunswick, New Jersey, 1978 and from Thomas F. Stinson and Stanley W. Voelker, Coal Development in the Northern Great Plains, Agricultural Economic Report No. 394, U.S. Department of Agriculture, Washington, D.C., January, 1978. Specific state taxes are those for Montana, as taken from Layton S. Thompson, The Taxation and Revenue Systems of State and Local Government in Montana as of 1976, Department of Agricultural Economics, Montana State University, Staff Paper 77-12, June, 1977.

development forecast can then be made. It is much easier to hold constant all statewide economic activity which is unrelated to coal development; otherwise, a statewide economic/demographic model (or other techniques for projecting economic activity) will have to be constructed.

Forecasting intergovernmental transfers is a difficult technical problem. Table B-3 also presents Montana state transfers by type to local governments. Federal intergovernmental transfers are also increasingly major revenue sources, both to state and local governments. The prediction of federal transfers, either to the state and especially to local governments is exceedingly difficult -- even for order-of-magnitude estimates. Each category of transfers is allocated based on a certain formula, usually consisting of economic/social variables by which need is measured. In theory, federal and/or state transfers can be estimated as a function of these variables, and for certain types of transfers (e.g., HUD Community Development Block Grant Funds) this approach can be applied. However, many intergovernmental transfers are based upon federal or state discretion. This applies, in particular, to transfers for local impact. These types of transfers, subject to all kinds of political and institutional constraints, are practically impossible to forecast with any accuracy. Two reasonable approaches exist for this problem. One is to sum individual transfers, forecast them as a function of economic or social proxies, and hope that all errors cancel each other out. The other is to forecast only those transfers that are amenable to prediction and to indicate where deficits can be made up by other transfers. Two manuals (Burchell and Listokin, 1978; and Chalmers and Anderson, 1977) can only recommend that the analyst "attempt" to forecast intergovernmental transfers.

B.2.2 Issues in Estimating Expenditures

In rural areas of the Old West Region, a major fiscal impact of coal development can be anticiapted to be new public construction. New construction will be necessary when the capacity of public infrastructure is exceeded by the demands of increased population and economic activity.

To be able to predict the magnitude of capital expenditures, two pieces of information are necessary: 1) the present capacity of each public facility or system, and 2) the threshold level at which increased population or economic activity exceeds present capacity for each public facility or system.

Present capacity cannot be known without interviewing public officials responsible for each affected facility or system, or by carefully reviewing appropriate public records regarding facility specifications.

Estimating threshold levels for new capacity requires a marginal cost approach (Burchell and Listokin, 1978). Marginal costing will estimate the required capacity per additional unit of demand, as opposed to average costing, which will measure capacity over all units of demand (arriving at an average capacity). Marginal costing assumes a nonlinear relationship between service delivery and demand, while average costing assumes a linear relationship. In the very long run, both average and marginal costing will yield similar results; however, at a given point in time, an estimate by one technique will lag the other. The implication is that marginal costing will yield a better estimate of the time when new construction will be necessary.

Both marginal and average costing are methods to arrive at the level of public services per population. Professional standards for public service delivery, of course, also exist, and can be used to project the need for capital expenditures (Burchell and Listokin, 1978; Chalmers and Anderson, 1977; Muller, 1975). An issue, that is not easily resolved, is the applicability of each technique. Marginal and average costing are derivations of the demand curve for public services. In theory, residents of a local area will exhibit their own unique preference for the mix of public services to be delivered; these preferences will be captured by the local demand curve for public service delivery, but not by professional standards. However, the actual delivery of public services is a function of supply as well as demand. Small rural areas are likely to have a tax base which cannot support public services at the level which local demand may warrant.

Where such a small rural community is faced with drastic economic and demographic growth -- and structural relationships are likely to change -- professional standards are more applicable than a demand curve estimated from a local history of frustrated demand (Intermountain Planners/ Wirth-Berger Associates, 1974). Such a demand curve is likely to underestimate the level of required services. A demand curve for a large city with a substantial tax base, estimated from local historical data, would exhibit no such problem and would be applicable. However, no research exists which empirically estimates the size where a community's tax base is large enough so that a demand curve based on historical data is applicable.

Other difficulties -- stemming from structural changes -- attend the measurement of a demand curve in smaller localities that will experience substantial growth. For example, residents of such small communities will be accustomed to a rural or small town culture. On the other hand, inmigrants attracted by coal development are often more likely to be accustomed to an urban culture and exhibit different demographic characteristics.[1] Social and cultural conflicts between natives and inmigrants are inevitable. While the assessment of such conflicts is beyond fiscal impact analysis, it is probable that the type and quality of public services demanded by inmigrants will be different from those demanded by natives. Moreover, temporary inmigrants, such as those associated with a construction work force, are likely to have services/facilities expectations and demands that are different from the other two groups.

A final result of population change upon public expenditures is that the cost of delivery may vary with population. There is substantial evidence that per capita expenditures change as the level of population served changes (Mountain West Research, 1975, Krutilla, et al., 1976). For certain types of functions, per capita expenditures may be expected to increase as the population increases (e.g., police

[1] Inmigrants are typically a younger population group than the native population, have different educational characteristics, income levels, etc.

protection) while for others (e.g., wastewater treatment), scale economies allow per capita costs to fall, at least to a certain point.

Because of these issues the measurement of demand curves is difficult, and implies a survey (of similar localities which have already been impacted by coal development) for their direct derivation. An approximation[1] of the demand curves might be estimated by regressing public service expeditures as a function of appropriate variables on the historical data of such similar localities. A variant of this approach is to regress a cross-section of counties of different population size (Intermountain Planners/Wirth-Berger Associates, 1974). Theoretically, the demand curves of natives, construction period inmigrants, and operation period inmigrants could be controlled for by partitioning the historical data -- using dummy variables -- into predevelopment, construction, and operation periods. However, such a technique has apparently never been tried in an empirical study.

B.2.3 Specific Fiscal Relationships

Thus far, general concepts and technical limitations have been addressed. This section discusses, in more detail, specific methodologies that are used to calculate local area public services expenditures and revenues. What is most notable is the lack of careful attention which has been given to revenue estimation.

B.2.3.1 Public Services Expenditures

The Fiscal Impact Handbook (Burchell and Listokin, 1978) is a manual, designed for practitioners, which aims to be a standard reference for fiscal analysis. Burchell and Listokin discuss six techniques which can be used to estimate public service costs of local land development.

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[1] It is an approximation because historical data for a "similar locality" -- similar in predevelopment economic and social characteristics -- is being used. The results will more or less approximate the actual demand curve to the extent that the "similar locality" is similar to the locality of interest.

The per capita multiplier technique assumes that, over the long run, current average operating costs per capita are the best estimates of future operating costs. Expenditures for each public service department are simply divided by population to obtain expenditures per capita. The methodology is simple, but does not yield useful information on capital expenditures timing in rapid-growth situations.

The case study method is a labor-intensive marginal costing technique. Heads of local public service departments are interviewed in detail about current capacity and costs of responding to specific levels of future population. This method assumes that department heads' estimates of standards for public service delivery are the most accurate available estimates.

Public service departments may respond to different subpopulations. Local department heads may be able to infer levels of service delivery from knowledge of total population alone; more accurate estimates of required services can be made if department heads are furnished with forecasts of subpopulations. This requires substantial manipulation of the basic population forecasts derived from the economic/demographic model.

With reference to Table B-2, for example, the broad categories of public services presented there could require information on the following subpopulations and demographic rates:

-- Employment-related services - number of unemployed, number of underemployed, average wage of unemployed, job-related injuries.

-- Health services - level of population by age-sex cohort, probability of illness and disease by type (requiring hospitalization, for outpatients).

-- Welfare services - level of population by age-sex-race cohort, family income distribution by income classes, probability of mental illness, probability of social deviations.

-- Education - level of population by age cohort and labor market characteristics.

-- Highways and streets - traffic counts, personal commuting rates, rates of industrial traffic, origin-destination information.

-- Other public works - number of households, number of new businesses by type, estimates of water and sewerage demand by new businesses.

-- Public safety - level of population, crime rate, fire flow information, number of households; if public safety includes a public housing authority, estimates of housing demand by income class and household size need to be provided.

-- Recreation and culture - level of population by age-sex-race cohorts.

-- General government - level of population.

In practice, such precision is not recommended by reviewers of fiscal impact techniques (Burchell and Listokin, 1978; Chalmers and Anderson, 1977; Muller, 1975) because the detailed data required simply is not compiled in a consistent manner across either localities or time.

Burchell and Listokin discuss four other techniques. Of these, three are based on the use of secondary data from the U.S. Census of Governments. Various ratios are computed between local public service delivery -- operating and capital expenses -- and local public service demand -- population. These ratios are cross-tabulated for municipalities by population size group and, sometimes, growth rate. The common assumption among these methodologies is that the demand curve among cities of a given population size and growth rate is identical. This may be a poor assumption when comparing rural boom towns with other communities across the nation, for reasons cited earlier.

The last technique discussed by Burchell and Listokin is the proportional valuation method, in which the ratio of local expenditures to total property value is derived and applied to the value of the development. The technique assumes that operating expenses are a function of the intensity of land use, and that property value is an appropriate proxy for land use intensity. In fact, the value of real property does not bear any direct relationship to public operating expenditures. It is more likely that employees (and their families) of the industry occupying the land directly consume the majority of public services.

Of the six techniques, the per capita multiplier and case study approaches use local data exclusively, and thus are more likely to derive the local demand curve than methods which use comparative data. The per capita multiplier technique is most commonly used in practice, because data are readily available. See, for example, University of Wyoming (1974), U.S. Corps of Engineers (1974), VTN (1974), Woodward-Clyde Consultants (1976), U.S. Bureau of Reclamation (1976) and Krutilla et al. (1976). The case study approach is preferable over the per capita approach because it directly addresses the problem of estimating capital expenditures. Interviews with local department heads should yield accurate information about present capacity per public service. However, if department heads estimate the level of services required for levels of future population, the danger exists that they will substitute their own demand curve or standards for that (those) of the public. This may seriously distort the validity of forecasts, particularly if the demand curve for inmigrants is significantly different from that of natives.

A possible solution to the problem can be to use regression analysis to derive the local demand curve if, for the reasons discussed earlier, this technicque is appropriate. The level of public service expenditures may be regressed as a function of the appropriate demographic variable. The resulting coefficient on the independent variable is a measure of marginal demand. If the problem -- that the demand curve for inmigrants is different from that of natives -- is thought to be serious, then a similar solution exists. Regression analysis can be applied to a similar local area which has already experienced coal development, partitioning the historical data as noted earlier. The resulting demand curve should account for demand by inmigrants. If neither of these techniques is appropriate, then the use of professional standards is called for. Obviously, much depends upon the unique local situation and the availability of data.

B.2.3.2 Revenues

As noted earlier, it is necessary to estimate the impact of development on state as well as local revenues. In principal, coal development can be translated to revenues by: 1) forecasting and appropriate economic variables, affected by coal and secondary development, which are taxed by both state and local governments, 2) applying the appropriate statutory or regulatory formula to derive revenues from that source, and 3) applying the appropriate statutory or regulatory formula to state or federal revenues to derive intergovernmental revenues. (The formulae for intergovernmental transfers are most often cast in demographic and social -- not economic -- terms; therefore, demographic variables will have to be forecast.)

As noted earlier, intergovernmental transfers pose a serious problem because they are strongly influenced by policy variables which are impossible to forecast. Another issue in revenue forecasting is the level of specificity at which economic/demographic variables are forecast. If the precise variable used in the taxation or redistribution formula is forecast, then the formula can be applied directly. If proxies for specific variables are forecast, then inferred relationships must be used to forecast revenues.

Burchell and Listokin suggest that revenues should be prioritized and that more thoroughness should be given to the prediction of the most important revenue sources (Burchell, Listokin, 1978). This is a most pragmatic suggestion. With reference to Table B-3, the following variables would have to be forecast to apply selected (Montana) state and local taxation formulae directly. (Unless otherwise indicated, based on formulae as described by Thompson, 1976; Minn. State Univ., 1977.)

-- Property taxes - assessed value of real property by type, assessed value of equipment

-- Gross proceeds tax on minerals - production in tonnage, contract sales price

-- Personal income taxes - households per income class

-- Fuel taxes - gallons purchased

-- Registration fees - new motor vehicles by type

-- Beer tax - amount sold

-- Liquor excise tax - amount sold

-- Liquor licenses - number of stores operating

-- Resource indemnity trust tax - gross value of product by mineral

-- Coal severance tax - production by BTU content, by type of mining; contact sales price

-- Insurance taxes - value of premiums

-- Inheritance taxes - value of estates, by value classes

-- Unemployment compensation taxes - payroll change by quarter, annual change in number of establishments (Raymond, personal communication, 23 August 1979).

-- Sales taxes - retail sales by product

A similar level of detail is required to directly apply other state and local revenue formulae. The economic and social variables so required are not generally produced by an economic/demographic model. Depending on the level of detail required and the level of effort available, it may be the case that variables predicted by the E/D model are used as proxies for variables required by the taxation and redistribution formulae.

A host of other variables can affect the level of local revenues, besides those economic/demographic variables which compose the tax base or distribution formula. Tax rates can change, based on policy decisions. In the case of a local government suddenly faced with rapid growth, in fact, an attractive option to raise revenues to the new levels required may be to raise the millage levy. Another policy variable might be a statutory change in intergovernmental transfers distribution. The value of the tax base may change -- in fact, this is a likely occurrence where significant growth takes place. Such variables are difficult to forecast. Local variables -- the millage levy, the taxable value of the property -- could be made functions of variables which themselves are impacted by development. Policy variables are impossible to forecast. If they are likely to vary within the forecast period, and the direction of their variation is known, the best the analyst can do is to assume several scenarios based on several possible variations.

The prediction of revenues, in summary, is made extremely complicated because of the sheer number of revenues, because of the large number of economic/demographic variables on which revenues are based, and because policy variables can significantly affect revenues. In this situation, the pragmatic strategy of prioritizing revenues is almost always a necessity. This way, the most important revenues can be estimated most carefully.

In practice, few revenues are estimated; those which are estimated are aggregated. Property tax valuation and assessed valuation associated directly with the proposed action are often the only revenue component

discussed (Bonneville Power Authority, 1977; Tri-County Electric Association, Inc., 1976; Wyoming Coal Gas Co. and Rochelle Co. Gas Co., 1974). In more detailed analyses, property tax revenue derived from other sources -- usually new residential housing -- is also projected (Bichert, Brown, Coddington, and Associates, 1975; University of Wyoming, 1975; Nuclear Regulatory Commission, 1977; Krutilla, et al., 1976; Intermountain Planners/Wirth-Berger Associates, 1974). If the proposed action is a mine, royalty payments (Krutilla, et al., 1976; Stinson and Voelker, 1978; U.S. Bureau of Indian Affairs, December 1976a and 1976b) and severance taxes (Krutilla, et al., 1976; Stinson and Voelker, 1978) is estimated. Only Krutilla, et al (1976) redistribute these state revenues back to localities. Sales taxes -- by direct payroll from the project -- is calculated by the University of Wyoming (1975), Ashland Oil and Shell Oil (1976), and Stinson and Voelker (1978). Income taxes by workers directly employed from mining is calculated by Stinson and Voelker (1978). Income taxes by total employment -- direct and secondary -- caused by mining is estimated by Krutilla et al. (1976). Raines, et al. (1978) estimates the summation of all revenues. No study reviewed here distributes any state revenues to local governments, with the exception of Krutilla, et al. and Raines, et al.

B.2.3.3. Calculation of Net Fiscal Impact

The comparison of public services and revenues impact is straightforward, once appropriate fiscal relationships have been estimated. Projections should be made for two scenarios: "with" and "without" resource development. The annual difference between the two scenarios is the annual impact of development. The annual and cumulative differences between impacted expenditures and impacted revenues is net fiscal impact.

B.3 Idealized Fiscal Impact Model

Conceptual issues which were previously discussed -- regarding each step in the entire assessment procedure illustrated in Figure 7-1 -- implied technical solutions. These, taken together, may be considered an idealized fiscal impact model. Its purpose is merely as a contrast

to descriptions of socioeconomic assessment practice reviewed in Section B.4 below. The contrast of an idealized model to assessments actually estimated highlights the technical constraints and uncertainties which limit the present state-of-the-art in socioeconomic and fiscal assessment. Such an exercise should help to define what is possible to estimate and how valid such estimates can be.

B.3.1 Scenarios

At least three scenarios should be forecast: a baseline "without development" scenario, a "with development" scenario that assumes resource production for the length of the forecast period, and a "with development" scenario that assumes a decrease in resource production after an initial period of substantial growth. The baseline scenario must be estimated to compare the incremental impacts of the other two scenarios. The difference between the baseline scenario and continued development scenario yields the fiscal impact of sustained growth due to development. The difference between the baseline scenario and a cessation of development scenario yields the fiscal impact of initial growth and sustained decline, as implied by the Rust-Alonso model.

B.3.2 Economic/Demographic Components

Spatially, the region of interest is the market area in which the coal development project is located. The model should have the capability of predicting the economic/demographic results of spatial (trading) relationships among centers located in the market area. The model should be capable of forecasting basic secondary development directly linked to coal, as well as nonbasic secondary development which is supported by all basic economic activity. The model should relate economic and demographic growth in a theoretically consistent manner -- a labor supply/demand component in which migration balances labor force. The model should be capable of forecasting detailed subpopulations -- age-sex-race cohorts. The model should be capable of allocating population by cohort to individual communities. Finally, the model should be capable of forecasting two scenarios -- one with coal development, and one without coal development.

B.3.3 Fiscal Component

The model should include all local governments within the market area affected by coal development. State government services directly delivered to local populations should be included in the analysis.

In order to estimate the timing as well as the magnitude of capital expenditures, marginal expenditures should be calculated and present capacity in each service should be identified. If it is possible, unique local demand curves for services should be derived using regression analysis. Where substantial local growth is anticipated, it may be appropriate (if possible) to estimate marginal expenditures in a like-sized local area where similar growth has occurred in the past; this ensures that any differences between the demand curves for migrants and natives are accounted for. If neither technique is appropriate, professional standards can be used.

Demand for a specific public service can be estimated with more confidence if the specific subpopulation which is the service's clientele is forecast. This requires substantial manipulation of population forecasts from the economic/demographic model. The degree of such manipulation depends on the detail required and the level of effort available.

All local revenues and those state revenues affected by coal and secondary development should be forecast. Like public expenditures, revenues are dependent upon variables which may not be forecast from the economic/demographic model. A reasonable approach is to prioritize revenues by importance, and to forecast either the variables upon which revenues are calculated, or close proxies for those variables. There is no best way to account for changes in policy variables and the attendant effect on revenues.

B.4 Fiscal Impact Analysis Examples

In recent years, a large number of fiscal impact assessments for projects representing several technologies have been carried out in the

analysis to report detailed descriptions of fiscal assessments in each of these studies. Rather, four studies have been selected for discussion. Each of these is relatively recent, each shares the impact resulting from coal development in a locality in the Old West Region, and together they represent a range of conceptual and technical approaches to socioeconomic and fiscal assessment.

The Capital Facilities Study: Powder River Basin (Intermountain Planners/Wirth-Berger Associates, 1974) is a study of all mineral mining impact on Wyoming local governments in the Powder River Basin. The Regional Economic and Fiscal Impacts of Energy Resource Development: A Case Study of Northern Great Plains Coal (Krutilla, Fisher, Rice, 1976) is a study of the impact of coal mining, coal-fired power plants, and coal gasification plants on Big Horn and Rosebud Counties, Montana. Coal Development in the Northern Great Plains (Stinson, Voelker, 1978) is a study of coal mining's effect on revenues to state and local governments in Montana, North Dakota, and Wyoming. Finally, the Assessment of Public Revenues and Expenditures Attributable to the Coal Industry in Wyoming (Raines, VanderMeulen, Griffin, 1978) is a study that assesses the fiscal impact of coal mining on state government and local governments in Wyoming.

Few characteristics of the "ideal" model were ignored by all four of the empirical studies, although no study included all -- or even most -- of its characteristics.

-- No empirical study included the effect on revenues of secondary economic development arising from coal development, despite the fact that Krutilla, et al forecast such secondary development. There is no technical reason why the revenue effect of secondary development could not have been forecast.

-- No empirical study included estimates of commuting patterns of place of work as opposed to place of residence for inmigrants. This appears to be a technical limitation based on data availability.

-- No empirical study forecast the impact of a "bust" scenario of local decline. Since the construction of such a scenario

involves arbitrary assumptions about the timing and rate of decline for coal production, no technical reason exists why such a scenario should not have been forecast. The limitation appears to be purely conceptual.

-- No study forecast fiscal impact in as much detail as recommended by the "ideal" model -- neither for all local governments in the trade area nor for expenditures and revenues by type. The limitation appears to be both conceptual and technical. No study either conceptualized a coherent economic (trading) area which might be affected by coal development or quantified spatial relationships.[1] Therefore, no study included all local governments that conceivably could be affected by coal development; this is largely a conceptual limitation. On the other hand, technical limitations -- data unavailability and labor requirements -- appear to be the reason why expenditures and revenues by type in the detail recommended earlier were not forecast.

-- Finally, although Raines, et al. forecast the impact on state expenditures, no other model did so. Raines, et al. forecast only the impact in total state expenditures, statewide -- not by community or county. The limitation here may be technical: data on state expenditures by locality may not be readily available. Or the limitation may be conceptual.

Taken individually, the variation in conceptual and technical approaches among the four studies is substantial.

B.4.1 Scenarios

Stinson and Voelker estimate the direct fiscal impact arising from individual model coal mines -- a 2-mm.-ton lignite mine, a 5-mm.-ton subbituminous mine, and a 9.2-mm.-ton subbituminous mine. Intermountain Planners/Wirth-Berger calculate the impact of "expected mineral development." Raines, et al. estimate the impact of all expected economic expansion with an emphasis on mineral development. Krutilla, et al. examine four possible coal development strategies -- a baseline scenario (present level of coal mining); a coal production growth scenario (based on the best estimates of knowledgeable individuals) that could be achieved without the construction of new mines; a growth scenario based on the construction of new mines; a growth scenario based on the construction of

[1] However, Krutilla, et al. discussed, in a qualitative fashion, spatial relationships when applicable to their analysis.

new mines; and a growth scenario based on the construction of new mines, new power plants, and a coal gasification plant. As noted earlier, no study postulated a scenario for decline.

The technique of forecasting under different scenarios is relatively easy to implement and considerably enhances the completeness of the fiscal analysis by postulating several possible directions for an essentially uncertain future. In contrast to other studies, that of Krutilla, et al. is rich in analytic value because several futures were postulated. However, once again, this is a function of the scope of work.

B.4.2 Economic/Demographic Components

Stinson and Voelker consider only the direct impact of coal mines. Coal mine employment, and family accompaniment and age characteristics obtained from a North Dakota survey (Leholm, Leistritz, Wieland, 1975) are the only economic/demographic variables used which affect the fiscal variables. Intermountain Planners/Wirth-Berger employed exogenous (total) population forecasts provided by the Wyoming Department of Economic Planning and Development (DEPAD). The methodology by which those forecasts were derived is unknown, but it is assumed that at least the direct effect of coal mining was taken into account. Raines, et al. also used exogeneous (total) population forecasts provided by DEPAD. These forecasts were obtained from a county-specific economic/demographic simulation model. This model is driven by expansion plans of a sample of existing industries in Wyoming by county (Wyoming Dept. of Administration and Fiscal Control, 1978). Secondary development, to the extent known by those industry officials who were surveyed, was therefore identified. Krutilla, et al. borrowed an economic/demographic model with a complex structure (Harris, 1973). The model is capable of forecasting secondary development, but not spatial trading relationships. Population is broken into four age groups and two races, but Krutilla, et al. make little use of such detail for estimating fiscal impacts.

Taken together, the four studies fall far short of conceptual and technical possibilities for economic/demographic modeling. In part --

specifically for Stinson and Voelker and Intermountain Planners/Wirth-Berger -- this is due to the more limited scope of the particular study. In part -- specifically for Raines, et al., and Krutilla, et al., -- this is due to borrowing an already existing model, presumably in an effort to conserve resources. The general effect is to limit the completeness of the fiscal impact analysis.

B.4.3 Fiscal Components

The four studies are most divergent in their technical approaches to estimating fiscal variables' relationships to economic/demographic variables.

Stinson and Voelker constructed a revenue model called ENERGYTAX, which is essentailly an accounting model through which state and local tax payments by source and flows of state intergovernmental aid can be computed. Conceptually, ENERGYTAX is closest among the four studies to the earlier recommendation that actual taxation and distribution formulae should be directly applied to appropriate economic/demographic variables, if that is possible. Stinson and Voelker, however, avoid many technical difficulties by only considering the production and employment of individual coal mines, rather than also estimating secondary development. In this way, they calculate close estimates of taxation and distribution bases. Therefore, their estimates of revenue impact are probably more reliable than those generated by any other study, but those estimates are also more incomplete.

Raines, et al. collected available fiscal data for the 23 counties, 75 cities or towns, 51 school districts, 109 special agencies, and 79 state agencies that made up the public sector of Wyoming in 1978. Detailed financial information by type of expenditure and revenue was unavailable, in a time series, for all of these entities, and Raines, et al., developed allocation methods to fill in the gaps.

Detailed economic/demographic detail was also unavailable to estimate demand and taxation bases for each of the localities. Rather than

allocate economic/demographic variables in a time series, as they did for financial information, Raines, et al. took an approach which is easier to implement, but which little theoretical basis. All financial information was summed to arrive at total state and local government expenditures and revenues for Wyoming, in a time series. At the same time, revenues and expenditures by type were summed to total revenues, capital expenditures, and operating expenditures. Relationships between expenditures and revenues were assumed to vary with population (demand for expenditures and tax base for revenues) and mineral production (tax base for revenues). Regression analysis was used to estimate these relationships. Total Wyoming state and local government expenditures and revenues were estimated as a function of total Wyoming population and mineral production. Statewide expenditures were then allocated back to localities on the basis of the distribution of their ratio to population presented in the 1972 Census of Governments. Revenues were allocated on the basis of (exogenously) forecasted county population and mineral production provided by DEPAD. The allocation methodology for expenditures is based on the questionable assumption that demand preferences for public services do not vary with growth.

Intermountain West/Wirth-Berger incorporated several of the characteristics of the "ideal" fiscal model, not all of which are identified in the brief description which follows. Individual public services for major towns, their appropriate school districts, and county governments were completely inventoried; present capacity for each service was, therefore, identified. Professional standards for capacity per population were identified for each service; these standards were applied to (exogenous) population forecasts to derive capital facilities timing, and multiplied by professional cost standards to estimate annual capital expenditures by service.

A complete data base for operating expenditures by type for all Wyoming local governments was compiled for the 1972 fiscal year. Regression analysis was applied to these expenditures to derive their demand curves. (The use of a cross-section rather than a time series assumes that smaller counties in the future will be similar to larger

counties in the present.) Individual types of expenditures were generally made functions of population, forecasts of which were exogenously provided by DEPAD. Intermountain Planners/Wirth-Berger's is the only study which estimated expenditures by type.

Revenues to local governments were forecast in two ways. An individual mineral-based revenue was forecast by assuming that its 1973 ratio to mineral production would remain constant for the forecast period; this ratio was applied to (exogenous) forecasts of mineral production provided by DEPAD. Local per capita revenues which are not based on minerals (property taxes, other taxes, fees and charges, and revenue sharing) were regressed as a function of population. Neither state transfers to local government nor state revenues were forecast. Rather, the net fiscal impact showed the need for state transfers.

Krutilla, et al., went into the most detail to forecast fiscal impacts. This is the only study that attempted to forecast state revenues and their distribution back to local governments, as well as local government finances. Only state revenues directly related to coal development -- the coal severance tax, the resource indemnity tax, royalties, the property tax on industrial property and "class two" vehicles, the personal income tax, and real and personal property taxes -- were estimated. Revenues from coal-related secondary development were not estimated. Like Stinson and Voelker, the formulae for these taxes were applied directly to forecasts of coal production and tax bases derived from coal production. Personal income tax revenues were regressed as a function of population. Where applicable, state revenues by source were then distributed back to counties, usually by direct application of the distribution formula and sometimes by close proxies.

Local revenues directly related to coal development were calculated, like state revenues, by applying the existing tax formulae. Real and personal property taxes were the only local revenue source, not directly linked to coal, which were forecast. These were estimated in two stages: (1) Assessed value of property was regressed (on a cross-section of all Montana cities and towns over 2,000 persons) as a function

of population. (2) The mill levy was regressed as a function of per capita income, population density, the per capita value of taxable property, and the locality's jurisdictional area in square miles.

Krutilla, et al., prioritized total local expenditures. Local education expenditures made up 60 percent of all expenditures. Therefore, local expenditures were partitioned into two categories -- education and "all other." "All other" expenditures were regressed (in a cross-section of all Montana counties) using the same independent variables as for the mill levy noted above. Education expenditures were forecast in an ad hoc fashion. Starting with the age distribution per county in the 1970 U.S. Census, and making several assumptions about the ages of children accompanying inmigrating populations, a cohort model for pupils advancing through school by grade was constructed. The resulting enrollments by grade were partitioned into two categories -- elementary and high school. Professional standards for educational facilities per student (both for education and for high school) and for construction costs were applied to estimate the demand for incremental capacity. These costs were annualized by assuming interest rates and amortization terms to arrive at annual capital costs. Operating costs were assumed to be equal to the state average per pupil in fiscal year 1974. The sum of operating and capital costs for education was compared to local revenue available for education; the difference was assumed to be the county's share of the state's school equalization fund, and added to other local revenues.

Both conceptual and technical approaches for estimating fiscal relationships vary widely across the four studies reviewed here. The wide range of conceptual approaches, the heavy use of proxies to forecast levels of expenditures and (particularly) revenues indirectly attributable to coal development, and the considerable use of ad hoc techniques highlights two major characteristics of fiscal impact assessment. First, the complexity of the local fiscal situation -- the sheer amount of types of revenues and expenditures and the wide range of variables that may affect their magnitude -- is extremely difficult to conceptualize into a model that can be empirically estimated. Second, the severe data limitations -- ranging from unavailability of actual financial data

for smaller localities to unavailability of data on economic/social variables that might predict expenditures and revenues by type -- forces the analyst to simplify the conceptual and technical approaches and to resort to proxies, ad hoc techniques, and simplifying assumptions in the actual estimation of expenditures and revenues.

B.4.4 Results: A Comparison of the Range of Estimates

Quantitative results produced by different socioeconomic assessments are difficult to directly compare. Projects differ significantly in their scale and over the period in which they operate. Local economies differ considerably in their complexity, their relative stage of development, the labor skills of their population, and their trading relationships. Local populations may differ in their vital rates and their demand for public services. Local governments in different states differ in the major sources of their revenues. For all these reasons, different projects in different localities at different periods of time can be expected to vary considerably in the magnitude and extent of their impact.

However, socioeconomic and fiscal assessments can be anticipated to produce a wide range of results if different conceptual approaches, technical approaches, and assumptions are used. The four assessments reviewed here are somewhat comparable, in that each analyzes the effects of coal mining (and, in one case, all energy projects) upon local areas within the Old West Region. It has been shown that each study approaches the assessment problem using separate assumptions and techniques. Each differs conceptually, as well. Raines, et al., Krutilla, et al., and Intermountain Planners/Wirth-Berger Associates include some effects of secondary development associated with coal mining. Stinson and Voelker calculate revenues in a more straightforward manner than do the other studies. Raines, et al. and Krutilla, et al. make some inclusion for state intergovernmental transfers. Intermountain Planners/Wirth-Berger estimates expenditures at a detailed level, using marginal cost analysis, unlike the other studies.

The quantitative results of each of these studies is presented in Table B-4. The figures which can be compared most directly are the

several ratios -- which are standardized -- presented there. Wide variability is apparent for each ratio. The ratio of population to total employment differs by 40 percent. The ratio of expenditures to population differs by a factor of over seven. Even for the two studies which examine the same geographic area -- Raines, et al. and Intermountain Planners/Wirth-Berger Associates -- this ratio differs by a factor of almost two. The ratio of revenues to total population differs by a factor of over eighteen among the three comparable studies. It differs by a factor greater than two for the two studies which examine the same geographic area. Finally, the ratio of revenues to project workers differs by a factor of two and one-half.

It is impossible to isolate the variability in these results which is due to different conceptual and technical approaches, as opposed to different project and local economy characteristics. However, the variability presented here illustrates the wide range of results which can be obtained from different, competent professional studies.

B.5 Conclusions

The comparison of existing fiscal impact assessments with the "ideal" model highlights conceptual and technical approaches which are possible, along with operational problems that restrict the present state of the art. These operational problems exist despite significant recent advances in socioeconomic assessment tools and techniques. The variation in results which are obtained from competent professional studies which use different techniques to overcome these operational problems is great.

The completeness aimed for in the "ideal" model appears to be beyond the present state of the art. A complete fiscal impact should encompass all affected local governments -- including those affected by secondary development -- and state government. In terms of analyzing each specific government, this is possible, and is limited only by research resources.

However, a complete fiscal impact should also include an analysis of the impact on revenues and expenditures by type. Technical

limitations upon this goal are numerous, of which data unavailability with which to measure, both financial variables and economic/demographic variables is the most immediate. However, the complexity of fiscal relationships -- the theoretical demand for services, the policy influence on intragovernmental transfers, the policy influence on tax rates, the responsiveness of tax rates to levels of demand for services, the sheer number of revenue sources and of tax bases for those revenues -- makes for severe difficulties in attaining completeness. First, a substantial research effort is required, and is not often feasible. Second, important fiscal variables simply cannot be forecast directly or must be forecast in crude, ad hoc ways at the present state of the art.

The most reasonable approach, given these limitations, is to aim for completeness, but to prioritize detailed variables in terms of their importance to the local situation, the scope desired for the analysis, and the research resources available.

The state of the art in economic/demographic modeling is more advanced. With available resources, all economic/demographic characteristics of the "ideal" model can be estimated. Simplifying assumptions are necessary to project vital rates, to estimate secondary development, to estimate the demographic characteristics of inmigrants. Such assumptions limit the analysis and should be clearly stated. As well, it may be necessary to survey in order to obtain commuting rates. All techniques used in modeling economic/demographic relationships could be further refined. However, in general, the limitations upon economic/demographic modeling appear to be mo e conceptual than technical.

The most severe conceptual limitation appears to be the universal neglect of the fiscal impacts of decline. If the proper fiscal relationships are estimated, a scenario which postulates decline is relatively easy to operationalize. The fiscal relationships necessary to show the impact of decline, in fact, may define the minimal level of detail necessary for fiscal impact analysis. These include: (1) capital expenditures, (2) operating expenditures for infrastructure maintenance, (3) operating expenditures for social services, (4) local government revenues, and (5) state government revenues. With these variables,

scenarios can be constructed that show both the impacts due to growth and those due to decline.

Operational problems severely limit the precision with which current state-of-the-art socioeconomic assessments can predict; order-of-magnitude estimates are all that can reasonably be expected. It is tempting, under these circumstances -- given operational constraints which force the analyst to make a long series of assumptions at each step of the socio-economic assessment process -- to use the "worst case" criteria in choosing assumptions. That is, the analyst uses that assumption which generates the greatest adverse impact. In this way, the impact of the "worst case" approach is presented. Such an approach has little utility for realistic planning. Order-of-magnitude estimates derived from the most realistic scenarios help immeasurably more in the actual implementation of state and local efforts to deal with project impacts. However, even order-of-magnitude estimates of direct costs represent only part of the total costs associated with coal development, as Sections 7.2 and 7.3 illustrate.